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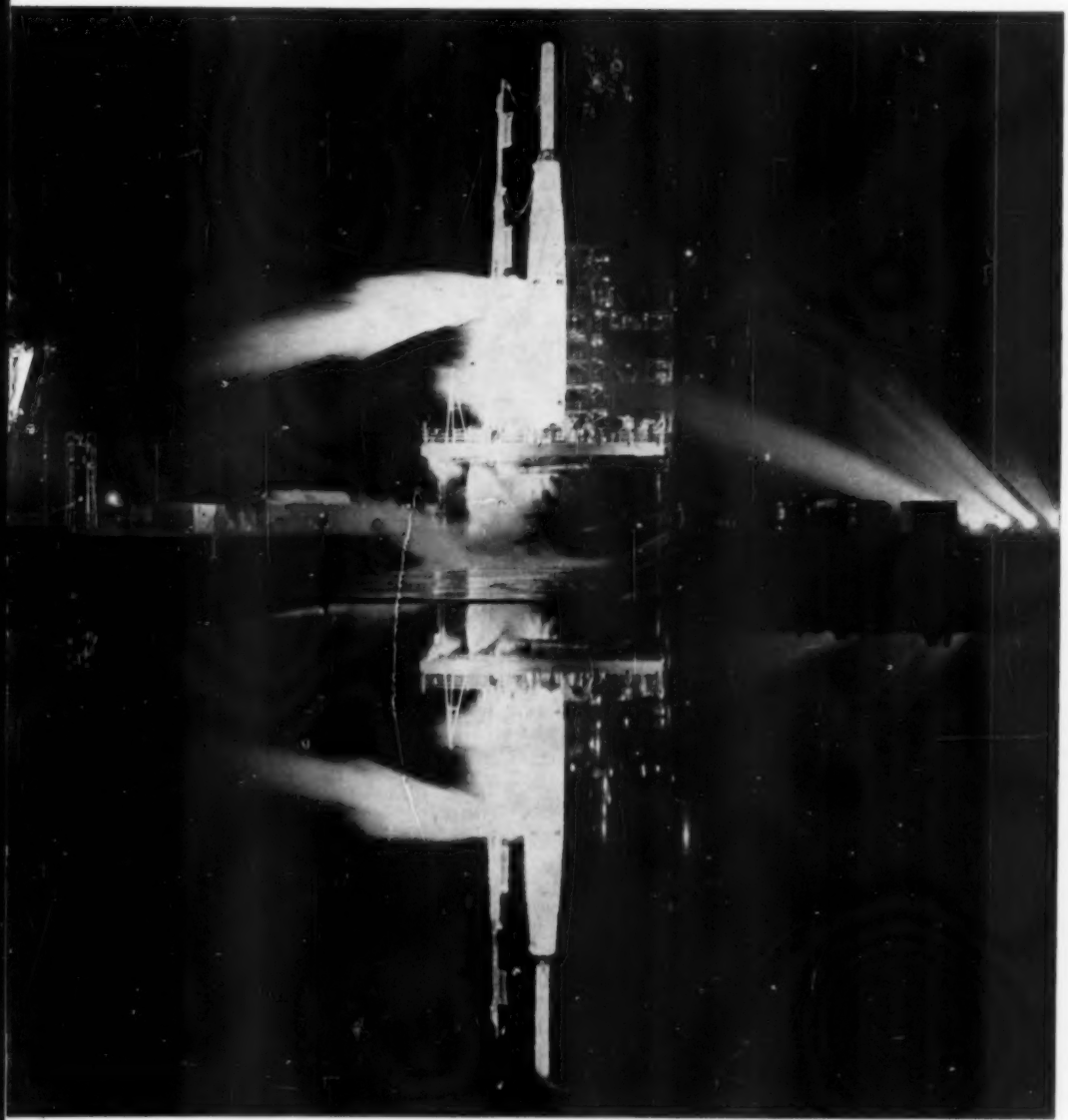

Ready to probe the moon ·

JULY-AUGUST 1959

Everything's changed but the trademark on the bearings

BUILT by the St. Louis Motor Car Co. in 1899, this car was the first equipped with Timken® tapered roller bearings. It's still running. And today every make of American car but one uses Timken bearings. The things that the trademark "Timken" stands for haven't changed. It still means the highest quality, the best-known name in bearings, and the kind of service you can't get anywhere else. It means better performance with longer life and less maintenance in machine tools, steel mills, heavy construction machinery, farm implements and tractors —wherever wheels and shafts turn.

"Timken" is a registered trademark that identifies all products of The Timken Roller Bearing Company—tapered roller bearings, fine alloy steel bars, seamless steel tubing and removable rock bits.

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first in quality for 60 years

ORDNANCE

LAND·SEA·AIR·SPACE

Forty Years of Leadership in American Armament Preparedness

VOL. XLIV JULY-AUGUST 1959 NO. 235

The Cover.—*This Thor-Able vehicle with its payload of instrumentation being made ready to launch from Cape Canaveral, Fla., was one of a series of lunar and space probes that have revealed new facts about the earth's magnetism and radiation belts (Air Force photo).*

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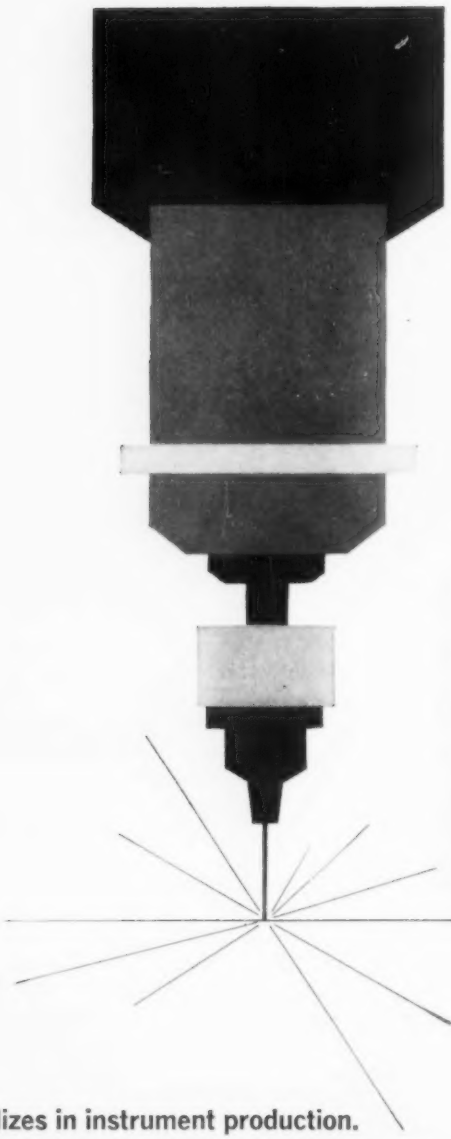

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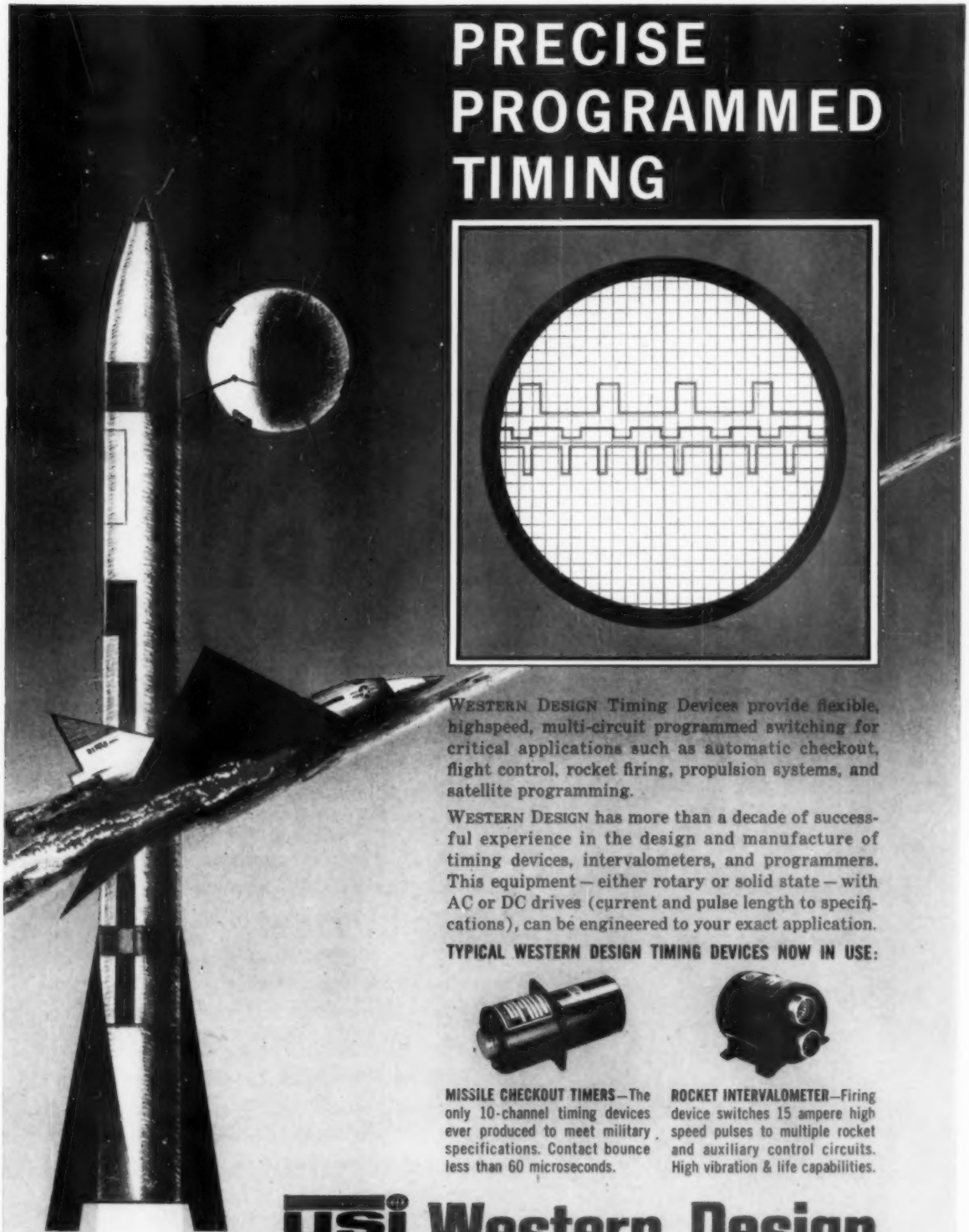

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"PACKAGING" MICROWAVES FOR MOUNTAIN TOPS

"TJ" radio-relay station at Black Mesa, Arizona

In Arizona, the telephone company faced a problem. How could it supply more telephone service between Phoenix and Flagstaff—through 135 miles of difficult mountain territory?

Radio offered the economical answer: a new microwave radio-relay system recently created at Bell Telephone Laboratories. Operating at 11,000 megacycles, it was just right for the distance, and the number of conversations that had to be carried.

But first other problems had to be solved: how to house the complex electronic equipment; how to assemble and test it at hard-to-reach relay stations way up in the mountains; and how to do it economically.

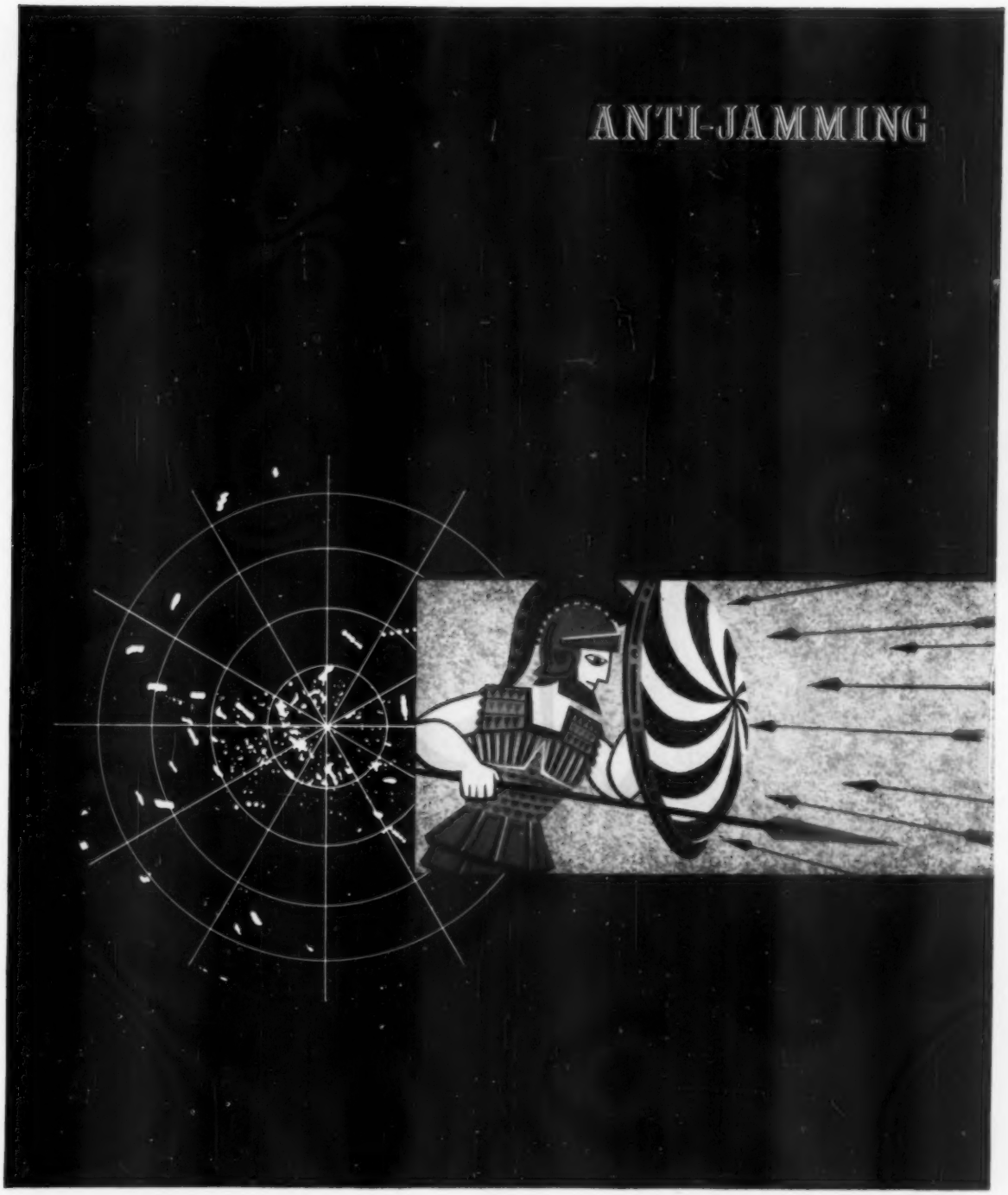
On-the-spot telephone company engineers had some ideas. They worked them out with engineers at the American Telephone and Telegraph Company and at Bell Telephone Laboratories. The result: a packaged unit.

The electronic equipment was assembled in trailer-like containers at convenient locations and thoroughly checked out. The complete units were then trucked up the mountains and lifted into position.

The system, now operating, keeps a watch on itself. When equipment falters, a relay station switches in stand-by equipment, then calls for help over its own beam.

The new Phoenix-Flagstaff link illustrates again how Bell System engineers work together to improve telephone service. Back of their efforts is the constant development of new communications systems at Bell Telephone Laboratories.

BELL TELEPHONE LABORATORIES *World center of communications research and development*



the picture is clear. Operational hardware to combat the gamut of radar jamming exists now at Bendix Radio. It enables targets to be detected despite natural and man-made interference. Jamming can even be turned to your *advantage*. Some of our fixes are unclassified. Others can be discussed on a need-to-know basis. If you have radar jamming problems, contact us to learn of our developments. Demonstration of equipment in operation also can be arranged.

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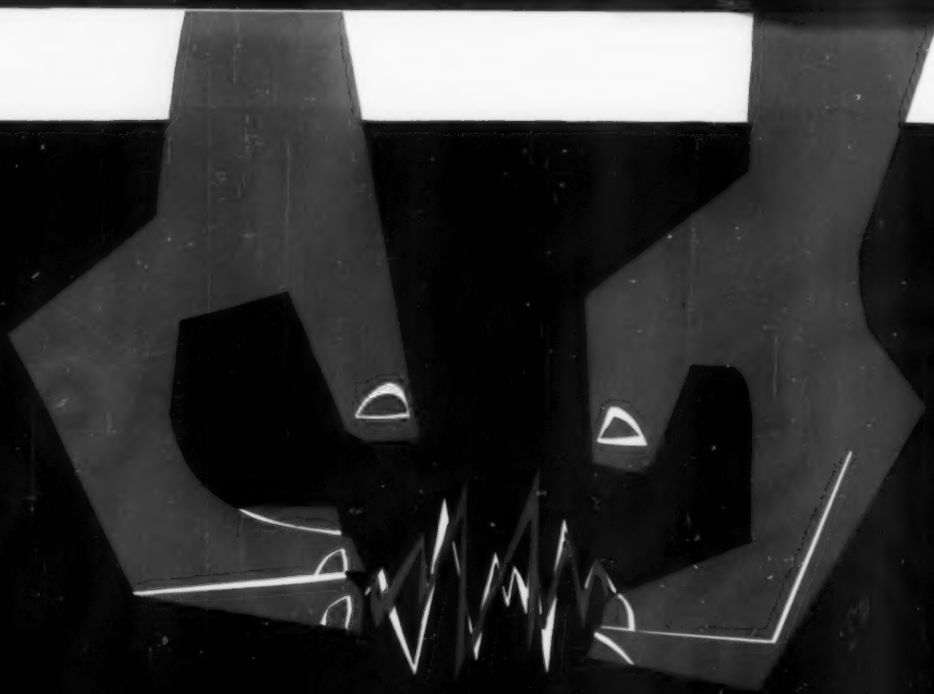

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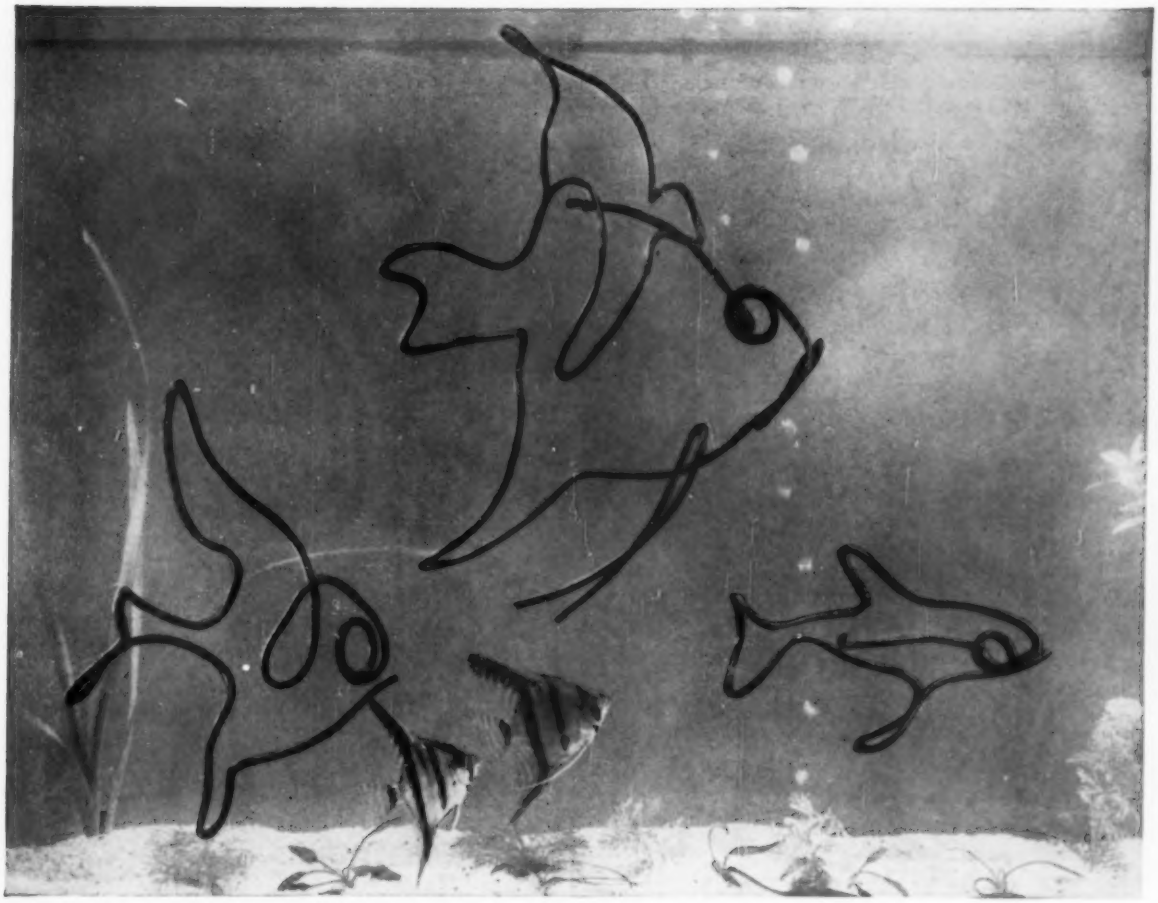

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YOUR tubing headaches are Bundy's business. Our tubing engineers will work with you at any stage in the development of your product. With years of problem solving experience, we can often suggest short cuts that cut costs of tubing parts—or find practical solutions to tough bends.

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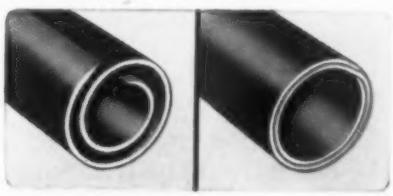
Why don't *you* take advantage of Bundy's complete service: expert engineering help, mass-fabrication savings, ***Bundyweld*** tubing. For more information see Sweet's Product Design File, le/Bu . . . or contact us!



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AIRBORNE...NEW USAF T-38 TALON!

The T-38 Talon fills a vital requirement of the Air Training Command. It is a lightweight, low-cost aircraft in which our new generation of space age airmen can safely master the art of supersonic flight.

Pioneering a new Northrop family of economical manned aircraft for the space age, the Talon is a direct result of teamwork between Norair and suppliers. This T-38 Team that made the trainer a reality is now producing it under USAF contract at Hawthorne, California. Soon to follow is the N-156F multi-purpose fighter, American-designed for our free-world allies.

The T-38 Talon stands as the latest airborne evidence of Norair capability and production know-how. Norair's creative management further adds to the accomplishment by trimming production costs with methods that include PACE — the unique Performance And Cost Evaluation program; new and superior quality controls; and Norair-conceived, years-ahead production techniques.

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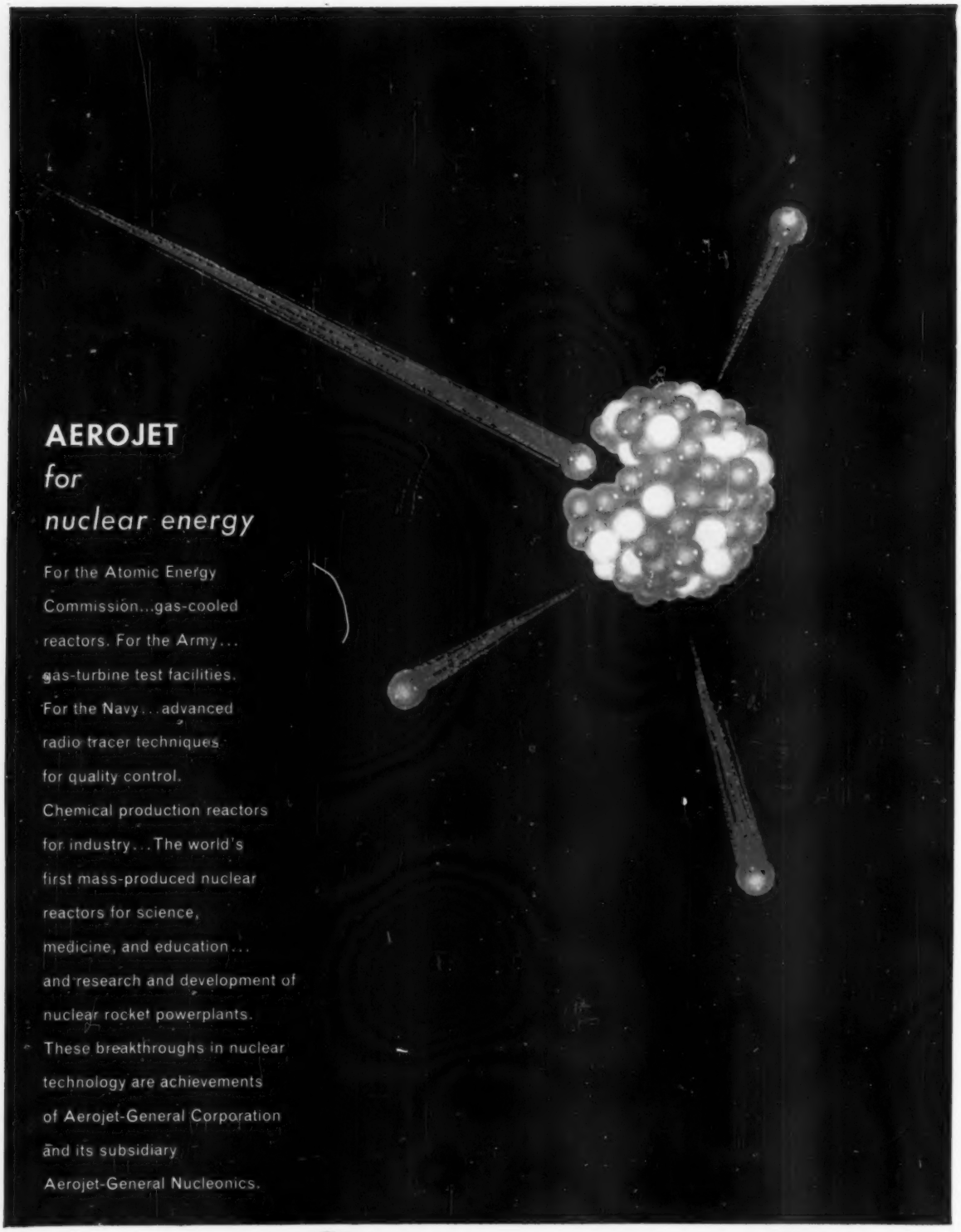
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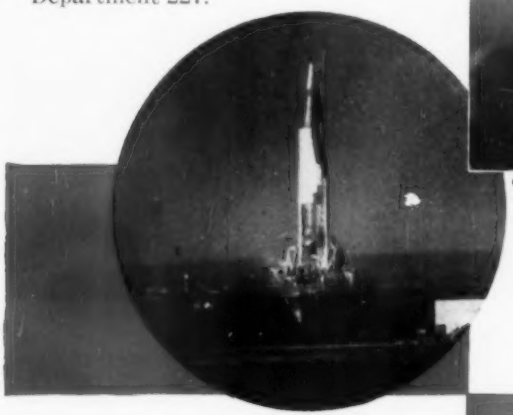
KOLLMORGEN Instruments and Systems for missile launching observation

Here are two different Kollmorgen products designed for the missiles field. One is a remote viewing device, the other is used for acquisition and tracking. These are essentially optical instruments, but most Kollmorgen products also include electronic controls and components. Kollmorgen specializes in design and manufacture of a variety of highly precise instruments and systems for both industrial and defense viewing and inspection applications.

We have recently prepared a twenty-four page illustrated brochure which describes our facilities and primary fields of interest. For a copy, please write to Department 227.

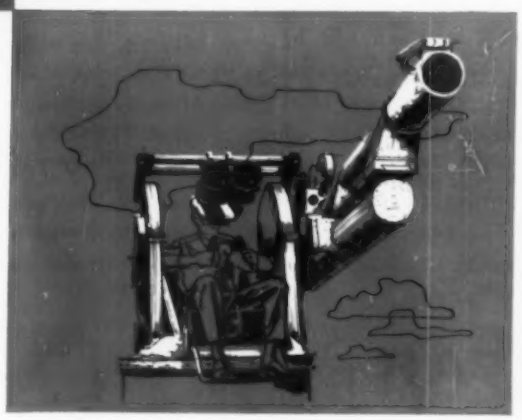
Official USAF photos

At Cape Canaveral, remote viewing of missile firing and static tests is accomplished with Kollmorgen bunker-type periscopes. Bunkerscopes have varying degrees of magnification, show images in true color and allow detailed observation of hazardous operations with no danger to personnel. The photograph at left was taken through a Bunkerscope at low power. For close-up observation and photography, the high power range brings the subject many times closer. Bunkerscopes are easy to operate, need no special care.



for missile tracking

Adapted from a basic Kollmorgen design, Missile Tracking Binoculars form an integral part of an acquisition and photography system which records the performance of tactical air-to-air missiles at China Lake Naval Ordnance Testing Station. These high-power, wide-field instruments enable an operator to spot and track a missile from before the time it is fired until it reaches its designated target.



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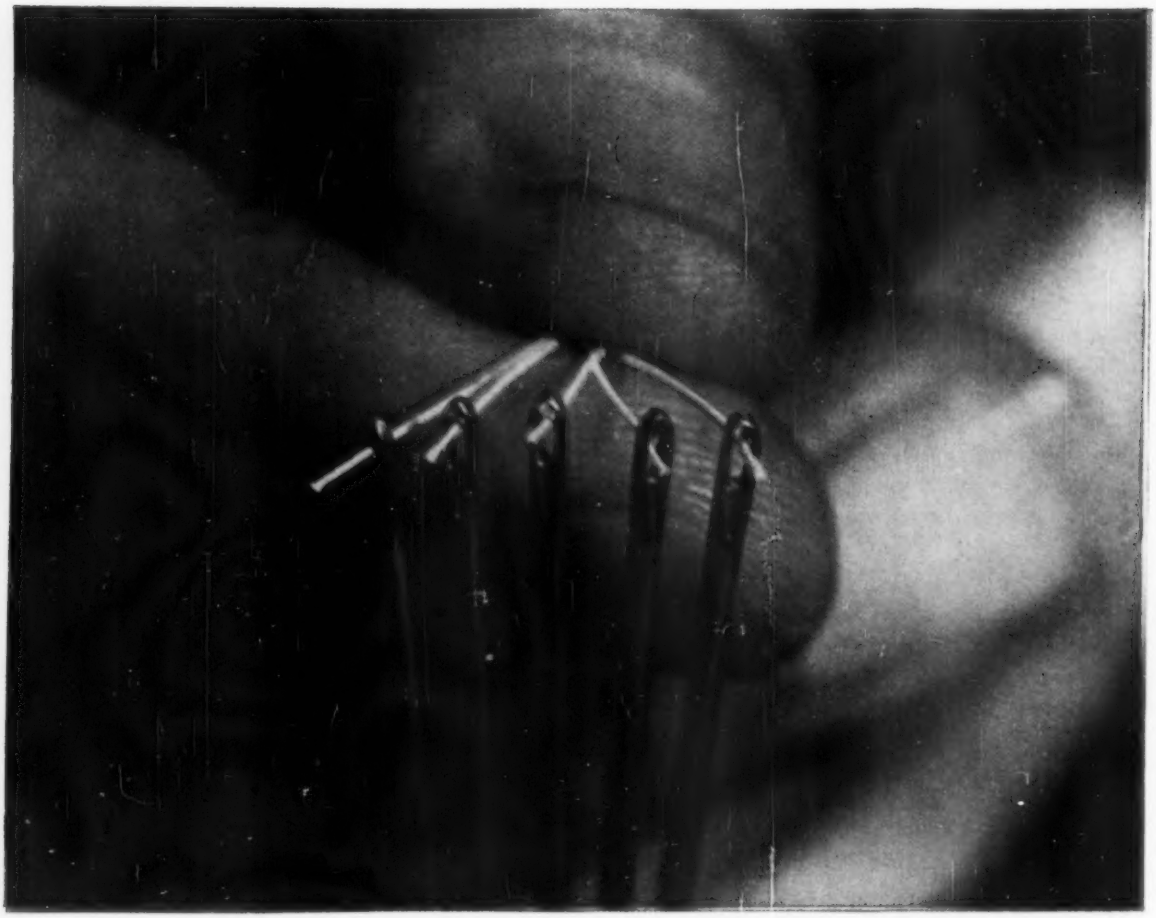

Cubic has, electronically speaking. And far greater precision is required of the five-target Cubic MOPTAR which will be used by the Federal Aviation Agency to evaluate experimental air-traffic-control systems. MOPTAR (Multi-Object Phase Tracking and Ranging), an *omni-directional* system requiring *no moving antennas,* provides startlingly accurate real-time position data. MOPTAR can be expanded to track *hundreds of aircraft* simultaneously with this same accuracy. The FAA installation will monitor other systems in tests at the new National Aviation Facilities Experimental Center near Atlantic City. It's a new use for Cubic's Space Age tracking systems developed under the forward-looking sponsorship of the United States Air Force. Now MOPTAR finds a non-military application in helping solve the problems of air navigation, an application that will lead to greater safety in the traffic lanes of the sky.

MOPTAR

Tracking systems by Cubic . . . reliable precision systems with Space Age capability . . . find application in air traffic control and, through the multiple-target potential of MOPTAR, in increasing the fire-power of America's guided missiles.

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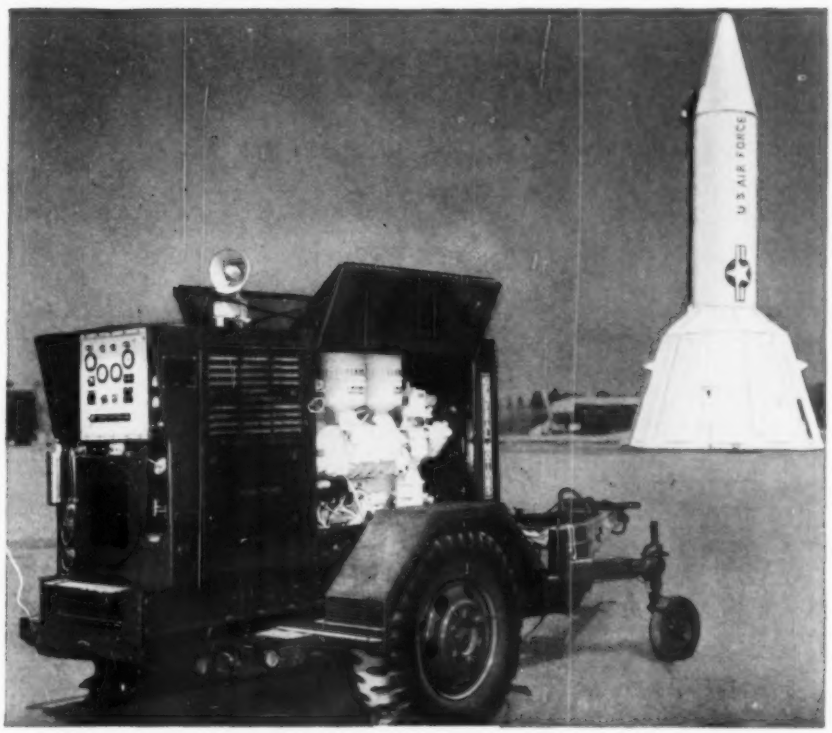

Developed in conjunction with the U. S. Army Corps of Engineers and the Army Ballistic Missile Agency, this GM Diesel Precise-Power Generator Set combines the time-proved GM "6-71" 2-cycle Diesel engine with a 100-KW. Delco generator equipped with a specially designed regulating system for utmost accuracy.

Weight of the unit is kept to a minimum (only 5,800 pounds) through extensive use of aluminum in both engine and generator components.

Starts and operates in–65° ambient—arranged for remote starting—load-sensing hydraulic governor on engine. *Operates satisfactorily on either Diesel or JP fuels because, unlike some 4-cycle Diesels, GM unit injectors do not require fuel oil with high lubricating qualities.*

This new 100-KW. Diesel Engine-Generator Set is designed to meet the most exacting performance standards in supplying power for radar, ground support and other facilities for various missile programs of the U. S. Army, Navy, Air Force and Marine Corps.

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These compact, highly mobile units are key components of the GM Diesel All-Purpose Power Line of engines and generator sets which are widely used, for example, on the DEW line, in naval transports, personnel craft and many other types of equipment · Engine and parts interchangeability permits standardization with other GM Diesels used in trucks, cranes, compressors, LOX plants and other equipment · Lightweight for maximum mobility—easily mounted on Army-type 2- or 4-wheel trailers · Trouble-free operation—long life without overhaul · Models of varying capacities in 50-, 60- and 400-cycle alternating current as well as direct current available · Easily paralleled.

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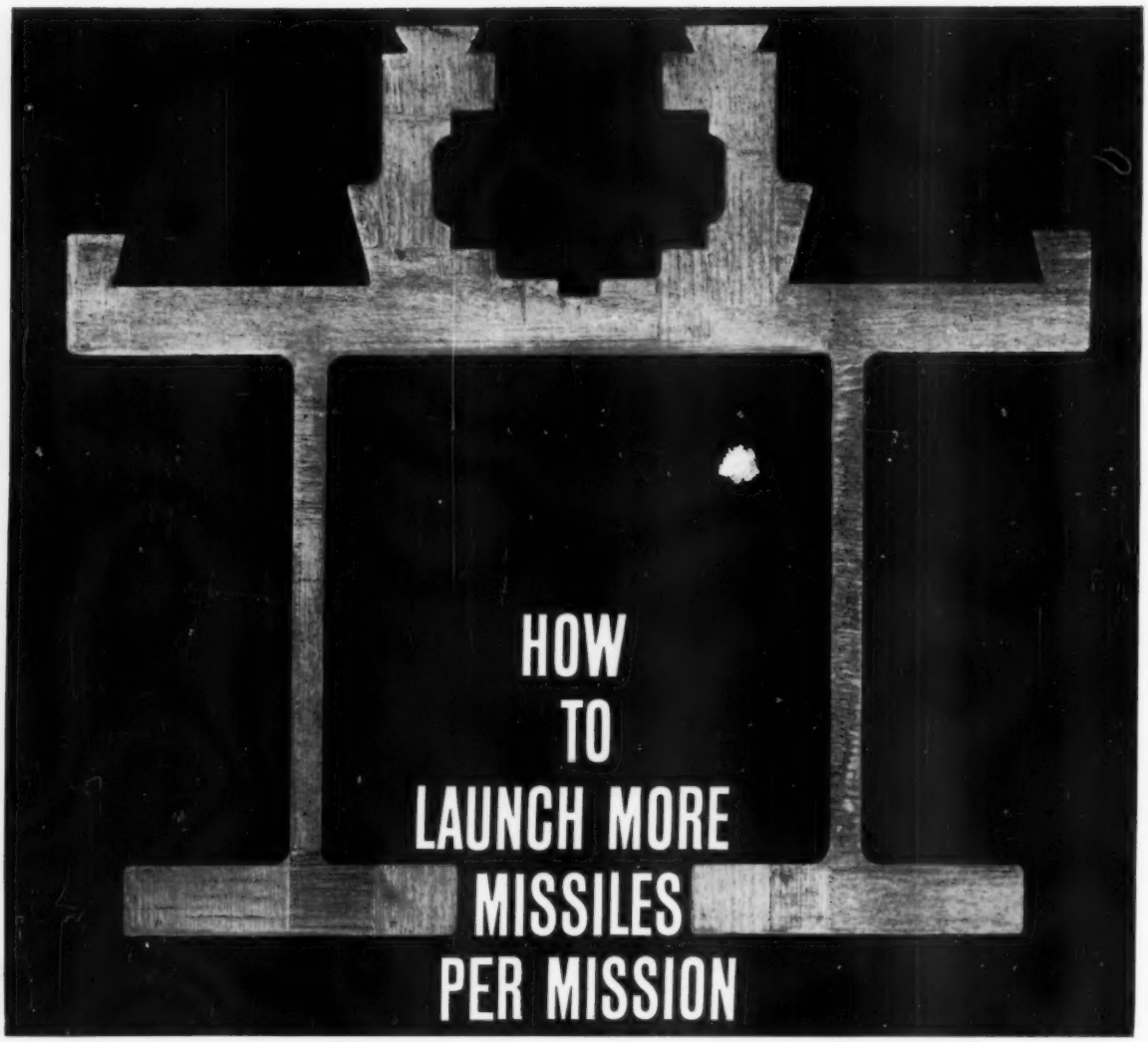

Terrier missiles already are operational on the cruisers *Boston* and *Canberra*, and on the destroyer *Gyatt:* facilities for carrying them will shortly be added to three other vessels by the U.S. Naval Gun Factory. This cross section of Alcoa Aluminum is part of the storage and handling tracks that store and deliver the missiles to the launcher.

NEW TERRIER surface-to-air missiles have vastly lengthened the reach of the Navy's antiaircraft arm.

THE NUMBER of these missiles carried on an operational U.S. ship is classified. So is the length of time it takes to bring one up from its storage racks and send it winging on its way.

THIS MUCH can be said: Thanks to the ingenuity of the U.S. Naval Gun Factory, with an assist from Alcoa® Aluminum, the storage and handling track permits launching a missile in a gratifyingly *short* space of time. And, thanks to the *lightness* of Alcoa Aluminum extruded forms, weight savings on the launching and handling facilities permit carrying at least *eight* extra missiles on every mission.

CONSIDER the storage and launching tracks, for instance—shown in cross section above. More than 1½ miles of this track is housed on the deck of every Terrier-carrying ship. With steel, the weight alone would be prohibitive. Extruded almost in finished form in Alcoa Aluminum, not only weight but machining costs are kept to a minimum.

ALL CREDIT goes to the men of the U.S. Naval Gun Factory for their skillful design. We'd like to take a small bow ourselves for Alcoa's supporting role. Perhaps there's some similar way in which we might lend assistance to *your* organization. If so, please let us know. Write Aluminum Company of America, 2031-G Alcoa Building, Pittsburgh 19, Pa.

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ALCOA ALUMINUM

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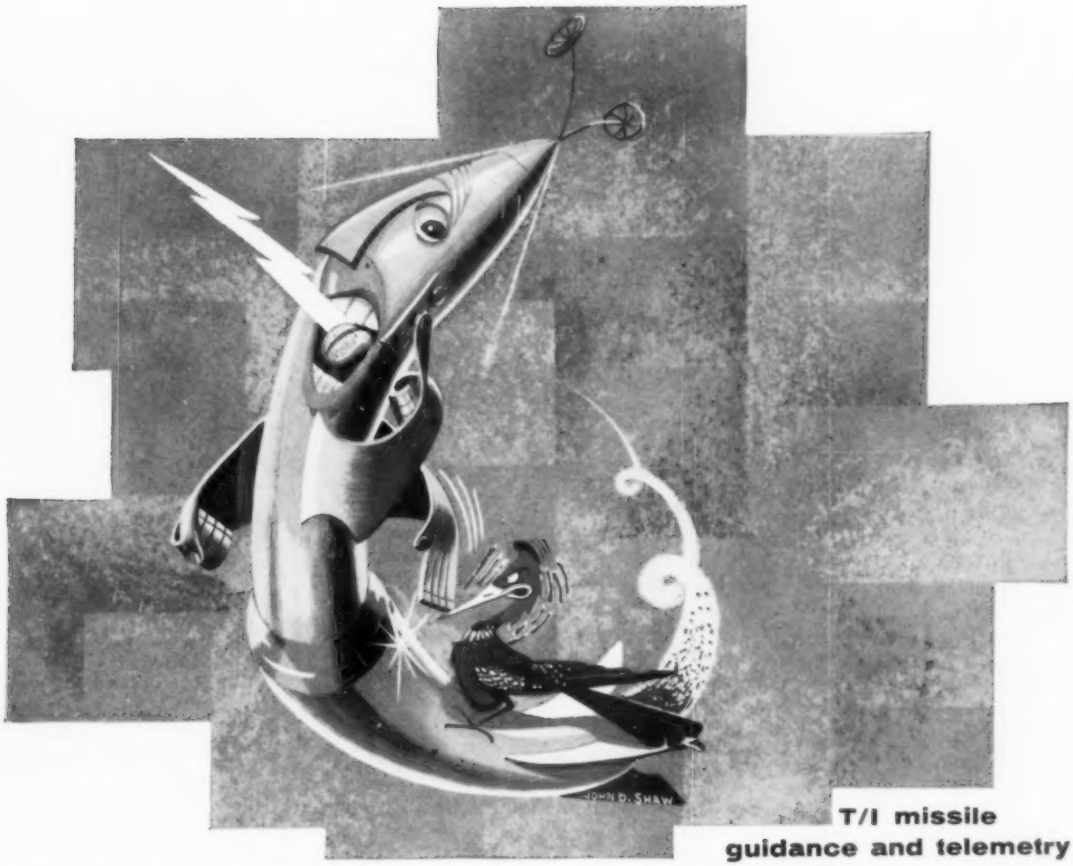


T/I missile guidance and telemetry

BEEPS WITH A HIGH IQ

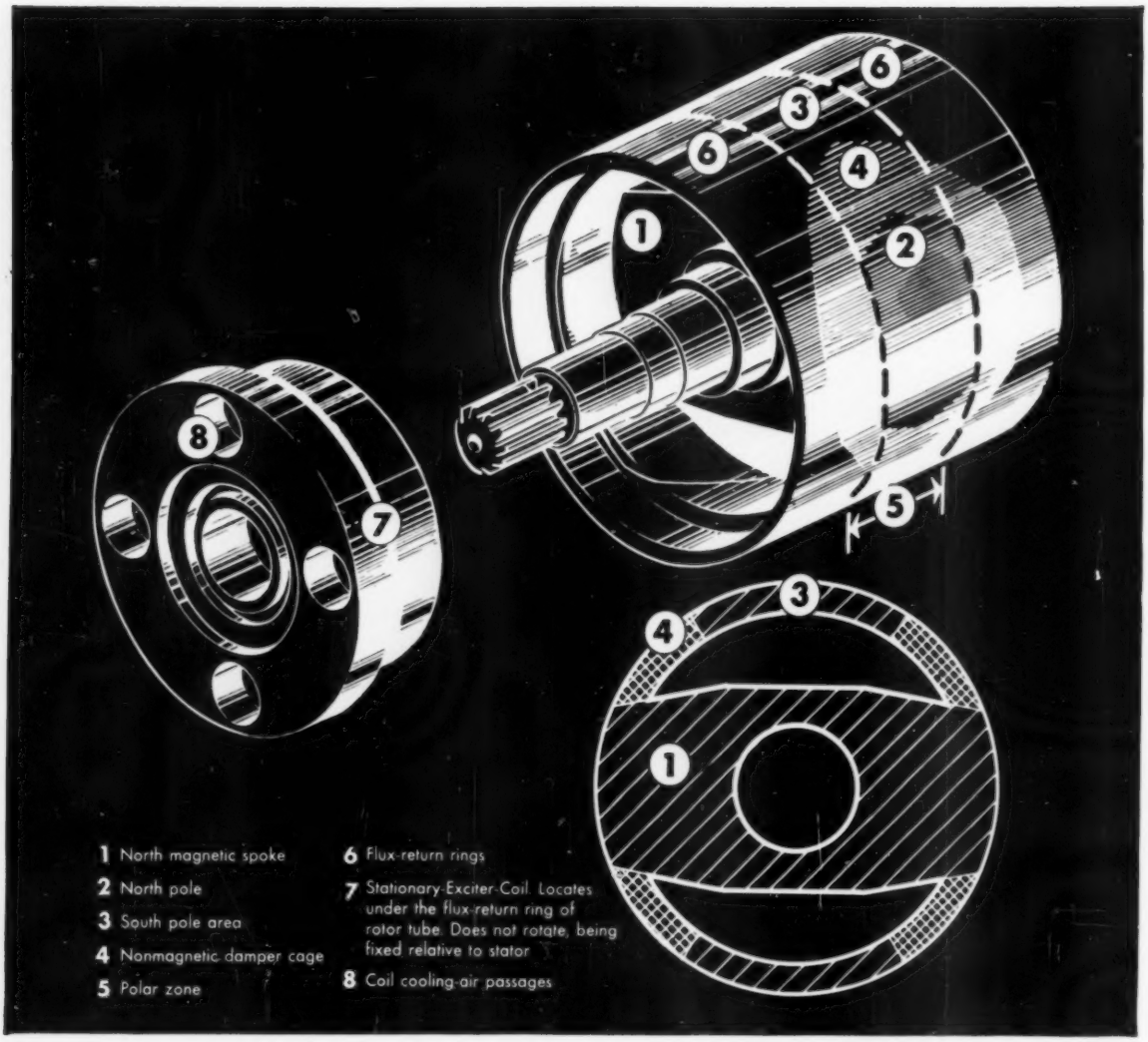
...for missile sensing, guiding and telemetering

Electronic signals that report the truth, the whole truth, and nothing but . . . wring the best performance from missile systems. By pushing beyond known capabilities in sensitivity and accuracy, Texas Instruments is producing "high IQ" systems and equipments for a dozen guided vehicles used in every basic mission: air-to-air, air-to-surface, surface-to-air, surface-to-surface — IRBM and ICBM—plus drone sensors and satellite instrumentation. TI exceeds tough specs against tight deadlines, regularly . . . specs asking solutions to problems never posed before. For detailed discussion, cleared personnel please write or call: SERVICE ENGINEERING DEPARTMENT.

RESEARCH/DESIGN/DEVELOPMENT/MANUFACTURING of systems for: *Air traffic control • Airborne early warning • Antimissile • Antisubmarine warfare • Attack control • Countermeasures • Missile systems Navigation • Reconnaissance • Space electronics; and on detector cells, engine instruments, infrared, intercom, microwave, optics, radar, sonar, telemetry, time standards, timers, transformers and other precision devices.*

APPARATUS DIVISION

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE
DALLAS 9, TEXAS


1 North magnetic spoke
2 North pole
3 South pole area
4 Nonmagnetic damper cage
5 Polar zone
6 Flux-return rings
7 Stationary-Exciter-Coil. Locates under the flux-return ring of rotor tube. Does not rotate, being fixed relative to stator
8 Coil cooling-air passages

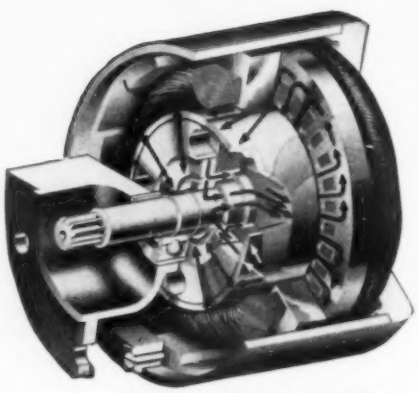
Picture of sophistication . . .

It shows why SECSYN* works twice as long as any comparable-purpose machine . . . needs almost no maintenance whether used to deliver kva, kw or hp. SECSYN's long-life secret is rotor simplicity: no brushes . . . no rotating rectifiers . . . no rotating copper field windings. And if liquid-cooled, SECSYN does not require coolant seals.

From this proved sophistication comes an ultra-speed range (up to 100,000 rpm) and extreme-temperature capability.

You can use SECSYN as an a-c generator to produce frequencies from 60 cps to 7000 cps . . . from 0.5 kva thru 125 kva. Or the design can be adapted as a d-c generator, synchronous motor or constant-speed motor.

If you're looking for the most economical and reliable power source yet designed, let's review your need in light of SECSYN. Contact Jack & Heintz, Inc., 17633 Broadway, Cleveland 1, Ohio.



Cutaway of complete SECSYN showing flux paths.

*Stationary-Exciter-Coil **SYN**chronous brushless machine.

JACK & HEINTZ, Inc.

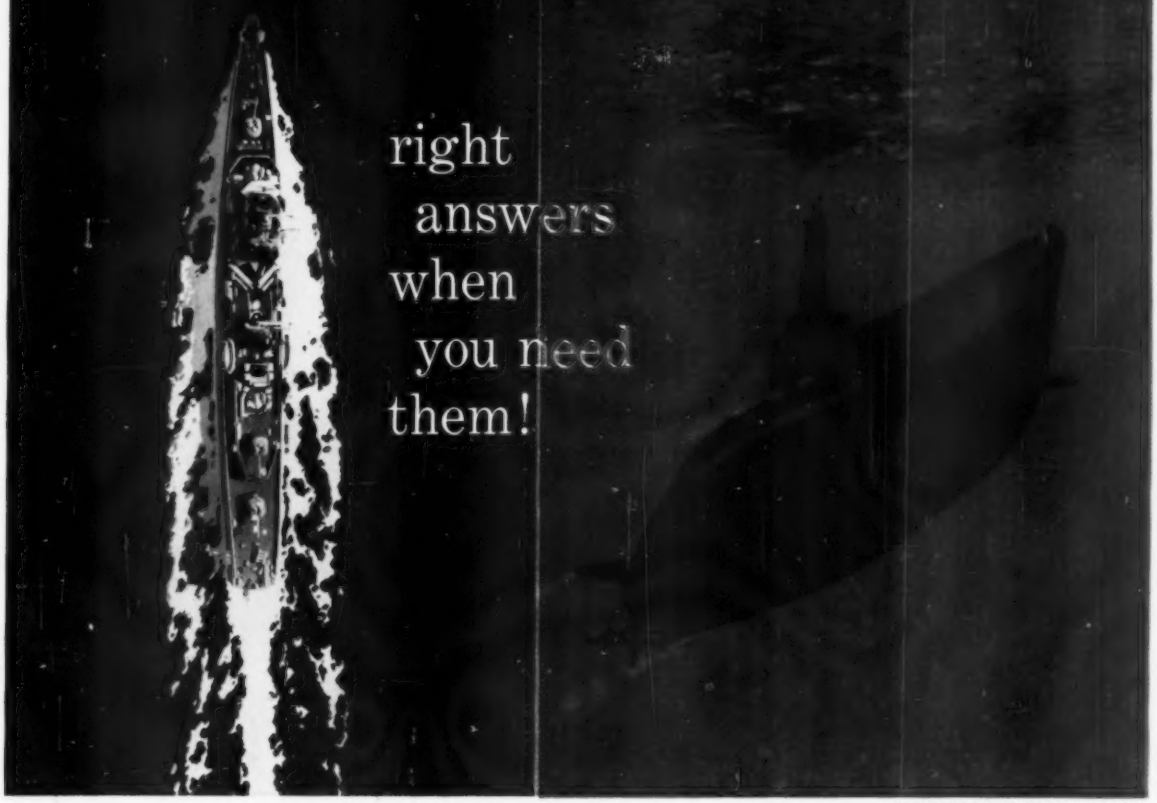
SYSTEMS FOR AIRCRAFT, MISSILES AND GROUND SUPPORT

TODAY'S ANTISUBMARINE WEAPONS CONTROL COMPUTER

THE TIME: *Early 1940.* **THE ACHIEVEMENT:** *A small, compact ballistic computer for the U.S. Navy.* **THE RESULT:** *The beginning of Librascope's leadership in the design, development, and production of weapons and navigation control systems and components.*

Today, Librascope-designed and manufactured electronic and mechanical equipment for the MK 113, MK 111, MK 110, MK 107, and MK 105 underwater fire control systems include computers, attack directors, torpedo and missile angle solvers, attack plotters, depth plotters, position keepers, target motion analyzers, stabilization computers, roll and pitch computers, and various indicators and control instruments. ■ Librascope's simulation laboratories provide the Navy with a means for testing and analyzing the performance of equipment under "real attack" conditions. In the field, our engineers assist in the maintenance and improvement of Librascope systems.

SHIPBOARD COMPUTERS



COURTESY NBC-TV FILMS' "THE SILENT SERVICE"

For information on career opportunities at Librascope, write Glen Seltzer, Employment Manager.

Librascope's experience creating new concepts in computer—control systems for both military and industrial use can be accurately applied to your specific needs. ■ For detailed information and solutions to your computer problems, write...

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PRECISION GYROS

A Proven Kearfott Capability. The increasing use of Kearfott gyros and gyro platforms in today's missile programs, underscores the company's leadership in gyro design and production. Such missile projects as the Atlas, Bomarc, Polaris, Snark, Subroc and Talos rely on Kearfott gyros or gyro platforms, as do the majority of manned aircraft now in service.

FLOATED RATE INTEGRATING GYROS. High accuracy miniature gyros specifically designed for missile use. The performance characteristics of these gyros are superior to any comparably-sized units available today. Hermetically sealed within a thermal jacket and ruggedly designed for adaptability to production methods. These gyros operate efficiently at unlimited altitudes. More precise performance characteristics can be provided in the same dimensions.

TYPICAL CHARACTERISTICS

Mass Unbalance:
Along Input Axis: 1.0°/hr maximum untrimmed
Standard Deviation (short term):
Azimuth Position: 0.05°/hr
Vertical Position: 0.03°/hr
Drift Rate Due to
Anisoelasticity: Steady
Acceleration: .015°/hr./g² maximum
Vibratory Acceleration: .008°/hr./g² maximum
Damping:
Ratio of input angle to output angle is 0.2
Characteristic Time:
.0035 seconds or less.
Weight: 0.7 lbs.
Warm-up Time:
10 minutes from −60°F
Life:
1000 hours minimum

VERTICAL GYROS. Provide accurate vertical reference in the form of two 400 cps synchro signals proportional to the sine of gimbals' displacement about pitch and roll axes. Gravity-sensitive vertical reference device provides electrical signals directly to torque motors which maintain gyro spin axis perpendicular to earth's surface. Hermetically sealed, they are unaffected by sand, dust, sun, rain, salt spray, humidity or fungus conditions as specified in MIL-E-5272A.

TYPICAL CHARACTERISTICS

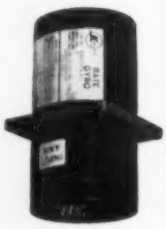
Repeatability to Established Vertical: To within a cone of half angle equal to 15 minutes of arc (± 8 minutes typical).
Free Drift Rate in 5 minutes Time: 2.5° maximum at room temperature. 3.75° at −54°C and + 71°C.
Erection Rate: 2.5°/Min.
Initial Erection: The gyro will erect to within ± 1° of established vertical in 60 seconds time after application of power at room temperature.
Vibration and Shock: The gyro will meet above characteristics after vibration of 0.060" total excursion cycling between 10 CPS and 55 CPS for 4.5 hours. Shock test in accordance with MIL-E-5272A Procedure 2.
Operating Life: 1000 hours minimum.

FREE GYROS. Provide extremely accurate reference in the form of electrical output signals proportional to displacements about outer axes. With 360° of freedom about outer axes (inner axis freedom depends on the unit involved), these gyros may be mounted to give output signals of either pitch, roll or yaw. Shock and vibration resistant, they are equipped with quick-starting motors for applications in high performance missiles and aircraft.

TYPICAL CHARACTERISTICS

Free Drift Rate: Within 0.5° in one minute time.
Shock: The gyro operates satisfactorily without damage after 60g shock of .015 seconds duration.
Hermetically Sealed: These instruments are hermetically sealed and are not affected by sand, dust, sunshine, rain, humidity or fungus conditions.
Operating Temperature Range: Gyros operate in ambient temperatures below −20°C to + 100°C. A maximum of 3 minutes of operation at 400°F will not damage these gyros nor impair their accuracy.
Weight: 5.5 lbs. approximately.

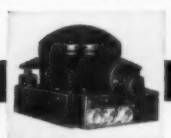
SPRING RESTRAINED RATE GYROS. Almost universally applicable in missile and aircraft designs demanding precise angular rate measurements in environments of extreme shock and vibration. Fluid filling provides added immunity to shock and vibration, reduces bearing friction in AC types and potentiometer wiper friction in DC types. Kearfott design advances permit 30 second warm-up, overcome fluid viscosity variations resulting from ambient temperature change. These gyros are single-degree-of-freedom, viscous damped, spring restrained, with gimbals supported by precision bearings. Compensatory damping mechanisms eliminate need for accessory heaters.



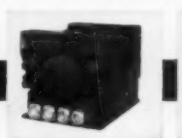
TYPICAL CHARACTERISTICS

Maximum Rate (°/sec.): 45-1000
Natural Undamped Frequency (cps) (± 10%): 16
Damping Ratio (of critical) over Temperature Range: .35 to .80
Operating Temperature Range (°F): −65 to +185
Vibration: 12 g's @ 20-2,000 cps
Shock (Motor Running): 60 g's for 6.5 milliseconds
Warmup Time (Sec.): 30
Weight (lbs.) (max): 1.5
Gyro Time Constant (Sec.): .012

Engineers: Kearfott offers challenging opportunities in advanced component and system development



Roll Stabilized Directional Gyro



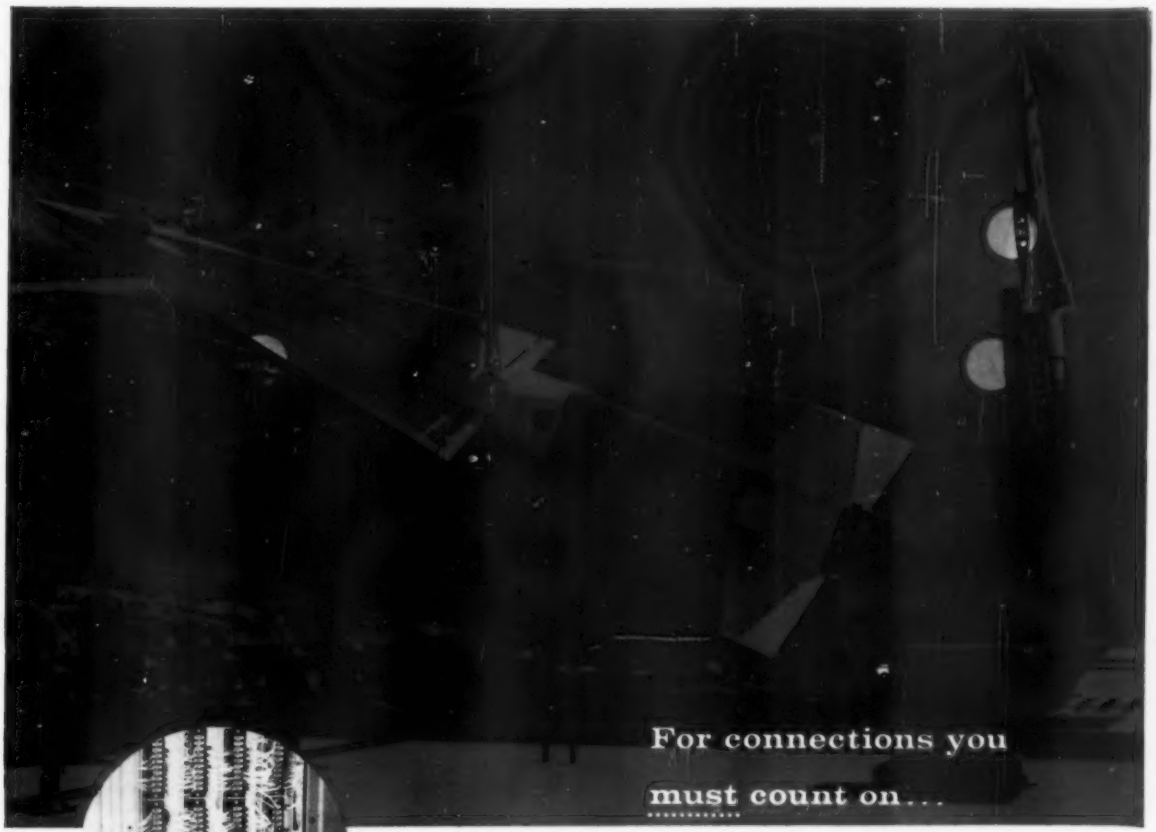
3 Gyro–4 Gimbal Gyro Reference

25 Pound Inertial Platform

Kearfott | A GENERAL PRECISION COMPANY

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.
A subsidiary of General Precision Equipment Corporation

Sales and Engineering Offices: 1500 Main Ave., Clifton, N. J.
Midwest Office: 23 W. Calendar Ave., La Grange, Ill.
South Central Office: 6211 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

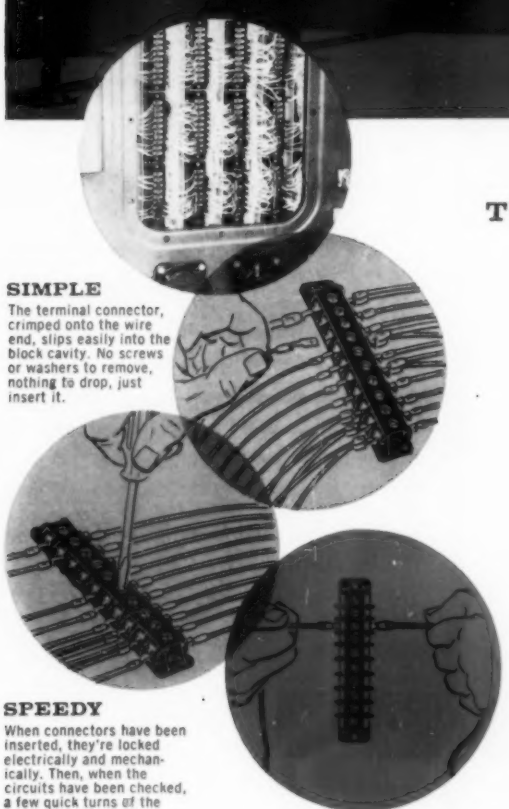


For connections you must count on...

be sure, be safe with

TWIN LOCK TERMINAL BLOCKS

Twin Lock terminal blocks offer the ultimate in terminal reliability, speed of assembly, and versatility of application. Molded of a lightweight phenolic base with reinforced barriers between cavities, the Twin Lock block will accommodate up to 40 connections quickly and surely. Twin Lock's exclusive, insert-and-tighten two-way locking action cuts harness assembly time to a fraction of that required by any other block. Twin Lock contact points, either tin plated, gold plated or plated to customer specification, assure lowest resistance connection. Wire end connectors, compatibly plated, can be supplied for manual or automatic assembly. Available in either vertical or side entry types, the Twin Lock block is applicable wherever a fast, positive, reliable electrical connection is required. For complete information on these remarkable new blocks, write for the T-1000 and T-1010 Terminal Block Brochure.



SIMPLE
The terminal connector, crimped onto the wire end, slips easily into the block cavity. No screws or washers to remove, nothing to drop, just insert it.

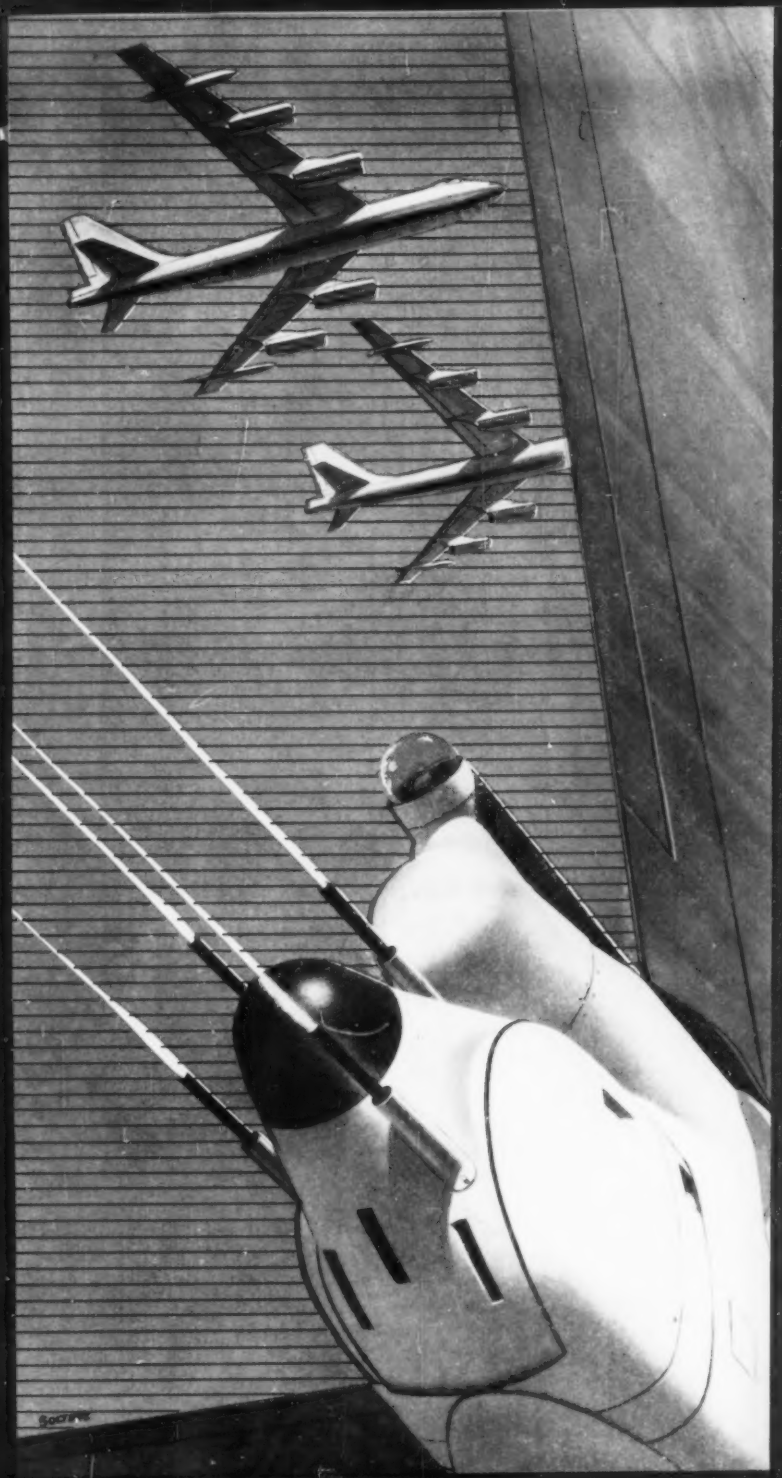
SPEEDY
When connectors have been inserted, they're locked electrically and mechanically. Then, when the circuits have been checked, a few quick turns of the lock screw and they're **double**-locked.

SURE
When the connector has been inserted and tightened, the Twin Lock terminal block connection is positive—electrically and mechanically. Over 100 lbs. force is required to break this connection.

TWIN LOCK INCORPORATED

1024 West Hillcrest Blvd.
Inglewood, California

Coliseum Tower, 10 Columbus Circle,
New York 19, New York



Crosley

And . . . . . .

Fire Control Systems for the B-52

New and greater responsibilities have been given Avco's Crosley Division by the U. S. Air Force. Long a producer of fire control systems for bombers, including the B-47 and B-66, Crosley recently was named prime contractor for the ASG-15 fire control system on B-52 bombers ordered for the Strategic Air Command.

Crosley now has complete responsibility for engineering, production and performance. Two of Crosley's large plants manufacture, assemble and test complete turrets, computers and radar units for the ASG-15 system that both "searches" and "tracks" to aim the guns that defend the B-52.

In the months and years immediately ahead, many new and ingenious improvements will be made in bomber defense. Crosley already is at work on several, and has achieved remarkable results that will be reflected in the bomber defense systems of the future.

Crosley's extensive experience and technical capability have made it the first name in fire control systems.

For further information, write to: Vice-President, Marketing-Defense Products, Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio.

OPPORTUNITIES FOR ENGINEERS

Crosley offers excellent opportunities to mechanical engineers with experience in airborne gunnery, and electronic engineers with experience in fire control, radar and servos. Write to: Director, Scientific and Technical Personnel, Dept. O-79E, Avco/Crosley, 1329 Arlington Street, Cincinnati 25, Ohio.

Avco / Crosley

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ROCKWELL TRACTION EQUALIZER

Only rubber-tired vehicles combine both mobility and speed . . . speed for fast highway movement and mobility to tame the toughest off-road terrain.

Now, with the addition of the new *Rockwell Traction Equalizer*, Timken-Detroit® Axles bring even greater mobility and rugged performance to military vehicles. The Rockwell Traction Equalizer *substantially increases traction.* This means new versatility for modern, multiple-wheeled rubber-tired vehicles.

For more than 50 years Rockwell-Standard has supplied major drive components for military vehicles. Today Rockwell-Standard can supply complete power transmission assemblies . . . everything between the engine and wheels. Rockwell's designing, engineering and manufacturing experience – plus advanced research and testing facilities – assures highest quality. Depend on Rockwell-Standard for the best in power transmission components for military vehicles.

SEND FOR FREE DESCRIPTIVE FOLDER ON THE NEW ROCKWELL TRACTION EQUALIZER

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CORPORATION
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research	prototypes
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ASK US to send you our new brochure, How To Handle A Guided Missile—and about the opportunities at WTA for engineering personnel who can concentrate unusual capabilities.

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W T A

979 Rollins Avenue • Rockville, Maryland

ATOMIC ENERGY

Fallout Meters

The Atomic Energy Commission and the Office of Civil and Defense Mobilization are keenly interested in developing for home use an inexpensive, simple, and effective device to detect and measure radioactive fallout. The two agencies have been working together toward this end since August 1957.

It is an established policy of OCDM that every home should have a battery radio set. Also, research carried out during the last year or more by the AEC and OCDM has included attempts to perfect a radiation-detection device which could be combined with the battery radio, hopefully at an additional cost of not more than $5 to $10.

Several companies have developed such radio-radiation detector combinations which are being considered. When these combinations are tested and approved for performance and low cost, the AEC and OCDM will strongly recommend them to the public.

Huge Particle Accelerator

The proposed 15 billion electron volt linear accelerator, which the AEC hopes to construct at Stanford University, eventually should be capable of operating at 45 Bev and would be a major advance in the machines available to science for investigating the mysteries of matter and energy.

The project would be established as a national facility for research, to be used by scientists from other institutions as well as those at Stanford. A procedure would be established for screening proposed experiments and scheduling the use of the huge machine.

The accelerator is planned for construction near the Stanford campus. The apparatus would be enclosed in two parallel tunnels, each nearly two miles long and covered by thirty-five feet of earth. On the basis of preliminary estimates, the project would cost about $100,000,000 for construction, $18,000,000 for research and development, and approximately $15,000,000 a year to operate after completion. The Commission would finance the project, and Stanford would operate the machine. Its construction would take about six years.

Linear accelerators drive nuclear particles in a straight path, rather than in a circle, as is the case in cyclotrons and synchrotrons. Electrons are injected at one end of the straight tube, and are pushed along at increasing speed by

pulsed microwaves until they strike a target at the other end of the tube. Information about the structure of matter is gained from study of the reactions produced by this bombardment with high-speed electrons.

Modular Power Plant

The AEC has signed a cost-plus-fixed-fee contract with the Martin Company, Baltimore, Md., to design, develop, construct, install, and test operate a factory-assembled, modular nuclear power plant. The proposal of the Martin Company to do the work was selected as a basis for contract negotiations from among nine proposals received in response to an invitation issued by the Commission last October.

The plant, to be built for the Air Force and installed at the Sundance Air Force Station in Sundance, Wyo., is one of a family of plants being developed for the armed forces under a joint program of the Commission and the Army Corps of Engineers. The Commission is providing funds for the nuclear portion of the plant and the Air Force is providing funds for the related generating equipment and other facilities at the site. The estimated cost of the contract is $5,387,450.

The design of the plant, designated PM-1, will provide for factory-assembled modules or units which can be air-transported to a remote site and rapidly assembled. The plant will have a pressurized water reactor, cooled and moderated by light water and fueled with highly enriched uranium. It will produce 1,000 kilowatts of electricity to power military electronic equipment and 2,000 kilowatts of heat for offices, barracks, and other buildings.

Tritium Available

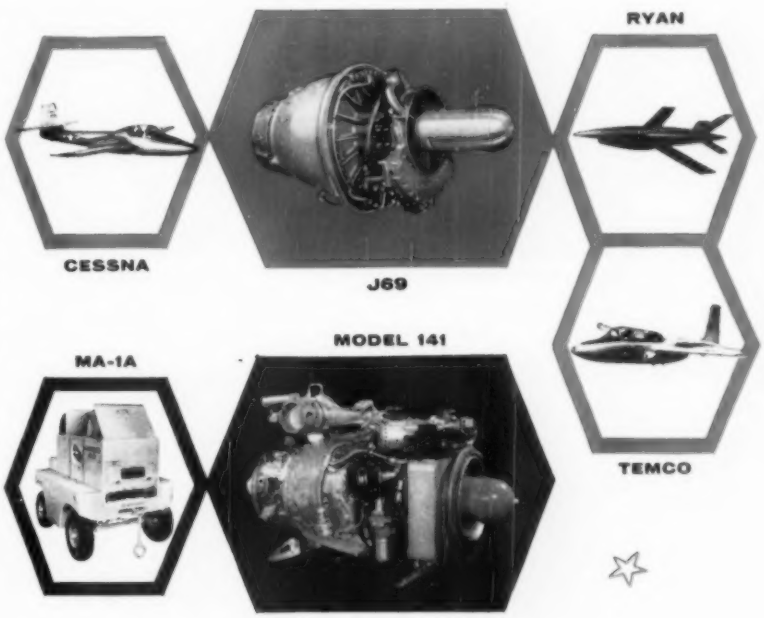
The AEC is making available 1,000,000 curies of tritium gas for civilian uses. When civilian demands exceed that amount, the Commission will consider supplying additional tritium on a continuing basis until private sources of supply become available. The radioisotope is for sale to licensed users from the Commission's Oak Ridge (Tenn.) National Laboratory at $2 per curie, plus a packaging and handling charge.

Tritium, the only radioactive isotope of hydrogen, is produced by neutron bombardment of lithium in nuclear reactors. It has a relatively long half-life of 12.46 years, decaying to stable helium 3. The radioisotope emits very low energy beta particles with no associated gamma radiation. The absence of penetrating radiation is an important safety factor.

The beta particles emitted by tritium are identical with the electrons bombarding the screen of the ordinary home television set. Just as the beam of electrons

CAE
• RESEARCH
• DEVELOPMENT
• PRODUCTION

Building Tomorrow's Power



Continental Aviation & Engineering Corporation has more than 10 years' experience with small gas turbine engines.... Four versions of the J69 turbojet—delivering 920 to 1700 lbs. thrust—are in operation today. . . . The Model 141 turbine air compressor engine is widely used in jet aircraft ground support equipment. . . . Research and development programs are continuously in process on uprated turbines, new turbine configurations, solid fuel propellents, and solid fuel ramjet vehicles.

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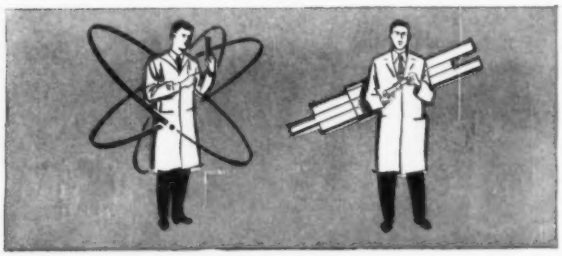
RACE™, a modern support concept, originated with **SPERRY**

Rapid Automatic Checkout Equipment plays a key role in assuring operational efficiency of weapon systems.

Five Sperry Pluses

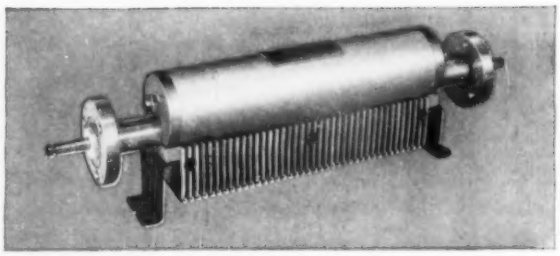
That Solve Ferrite Problems Fast

(other solid-state materials as well)



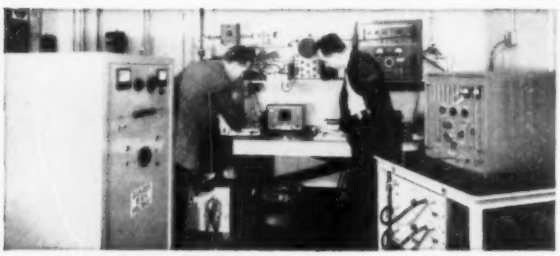
1. CREATIVE CLIMATE–

for the type of research and development brains eager to go ahead of ideas already established and in use – has attracted the top *scientists* of the field to Sperry Microwave Electronics. This in turn has brought top *engineers* to the task of converting developments into dependable, advanced products.



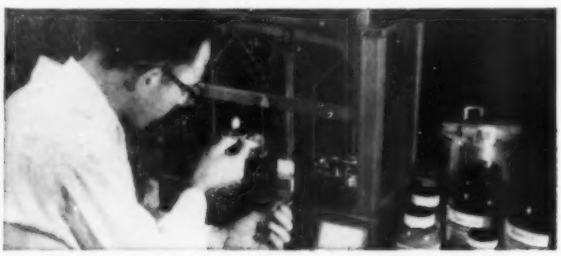
2. PRACTICAL EXPERIENCE–

Sperry Microwave Electronics has pioneered in extremely broadband frequency range components at high and average power levels (such as this ferrite isolator designed for countermeasures systems) – in S-band and below for high power components, and in many special devices.



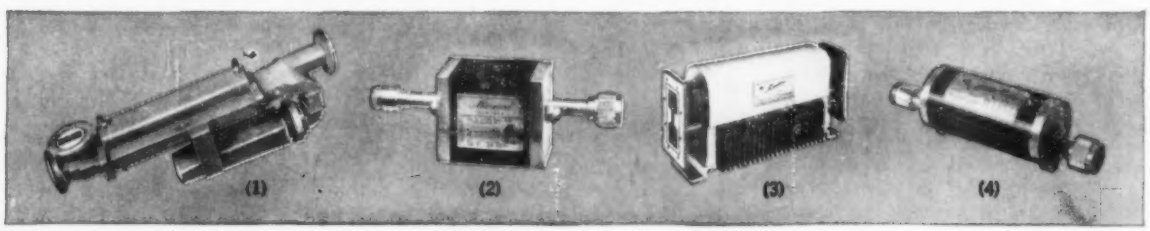
3. LATEST EQUIPMENT–

laboratories – and laboratory equipment such as this – are common in Sperry's modern 85,000 sq. ft. plant in Clearwater – and with it the latest production equipment.



4. CONTROLLED MATERIAL–

key to the reliability and repeatability of ferrite and other solid state devices – is produced by Sperry to assure consistent quality.



5. PROVED PRODUCTION– already in use is Sperry "hardware" such as (1) Duplexer; (2) Ferrite Equalizer; (3) High Power Isolator, and (4) Low Power Isolator.

You are invited to use Sperry facilities to the fullest–and take advantage of the investment Sperry has already made in initial research and development. Write:

SPERRY

SPERRY MICROWAVE ELECTRONICS COMPANY, CLEARWATER, FLORIDA · DIVISION OF SPERRY RAND CORPORATION

Address inquiries: Clearwater, Florida, or Sperry Gyroscope offices in Great Neck · Cleveland · Dayton · New Orleans · Los Angeles · San Francisco · Seattle

traces a luminous path on the phosphor covered screen, the beta radiation from tritium mixed with phosphors produces continuously glowing luminous materials having a great variety of uses.

Other applications of tritium include its use in radar and other specialized electron tubes to maintain partial ionization, thus assuring more dependable operation; in experimental fluorescent light tubes, indicating the possibility that accessories such as starters and transformers can be eliminated; as tracers in the study of oil-well stimulation methods and refinery operations; and in small portable accelerators, used in oil-well logging, which produce high-energy neutrons by bombarding a tritium target with deuteron ions. The devices are lowered into oil wells to obtain geological information from study of neutron reactions with the various strata.

U. S.—Euratom Program

The European Atomic Energy Community (Euratom) and the United States Atomic Energy Commission announced recently that private and government enterprises in the six countries comprising Euratom have been invited to submit proposals to build and operate nuclear power plants under the joint United States—Euratom nuclear power program.

The objective of the program is to install within the Community in the next 4 to 6 years approximately 1,000,000 kilowatts of electrical generating capacity in an effort to achieve economic production of nuclear power to meet the growing needs of Western Europe.

The invitation was issued by the Euratom Commision in Brussels following the coming into force of the Agreement for Cooperation between the United States and the Community.

International Cooperation

An Agreement for Cooperation in the civil uses of atomic energy between the United States and the International Atomic Energy Agency was signed on May 11, 1959, in Vienna. The agreement will make it possible for the Agency to draw on the 5,000 kilograms of uranium 235 pledged to the Agency by President Eisenhower at the conference which approved the IAEA statute at United Nations Headquarters in 1956.

In addition to the 5,000 kilograms, the United States has pledged to match the total amount of special nuclear materials made available by other members of the Agency up to July 1960. The government of the U.S.S.R. is making available 50 kilograms of uranium 235 and the government of the United Kingdom has agreed to supply 20 kilograms. As the U. S. has agreed to match the amounts made available by other members, the total amount of uranium 235 that is now transferable by the U. S. to the IAEA is 5,070 kilograms.

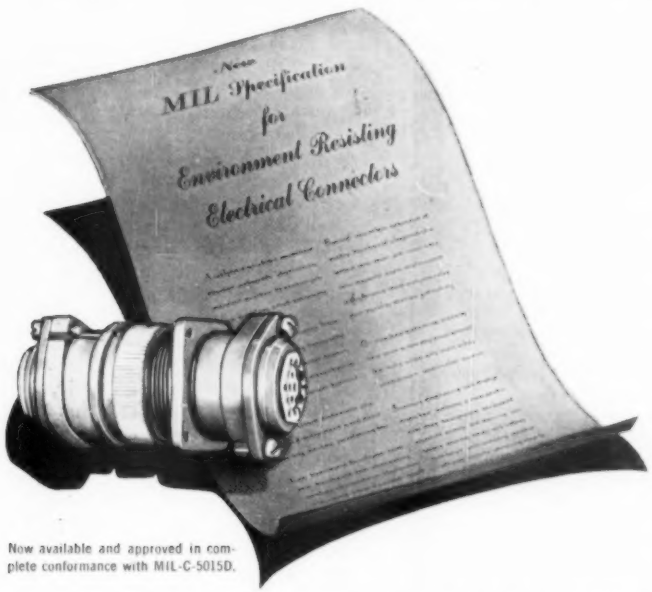
New Production Reactor

The AEC has entered into a cost-plus-fixed-fee contract with Kaiser Engineers, Division of Henry J. Kaiser Company, Oakland, Calif., for construction of the New Production Reactor at Hanford Works, Richland, Wash. The proposal of Kaiser Engineers to perform this work was selected from fourteen submitted in response to AEC invitation. The same firm built two of the eight reactors at Hanford.

The NPR project was authorized by the Eighty-fifth Congress at a total cost of $145,000,000. Estimated cost of work to be performed under the contract with Kaiser Engineers is expected to be about $100,000,000.

Design and engineering work on the reactor is being performed by General Electric Company, the Commission's prime operating contractor at Hanford Works. Burns and Roe, New York City, are supplying architect-engineering serv-

NEW BENDIX MS-R ENVIRONMENT RESISTING ELECTRICAL CONNECTOR



Now available and approved in complete conformance with MIL-C-5015D.

This new connector answers the demand from the aircraft industry for a shorter, lighter and more reliable environment resisting connector. This connector will inactivate practically all other MS types and the Military has assigned a new class letter R to insure incorporation of this better connector in all new designs.

An important reliability feature of the new MS-R connector is an "O" ring at the main coupling joint which provides for the best possible sealing and more positive inter-facial compression and assures complete performance compatibility among all approved MS-R connectors. Establishment of the MS-R connector as the "universal" military connector is testimony to the record of previous MS environmental resistant connectors using resilient inserts as pioneered by this Division. In the Bendix* connector, wire sealing is accomplished by an exclusive slippery rubber grommet which permits convenient wire threading and grommet travel over wire bundles.

Write for more complete information on this latest addition to the ever-growing family of Bendix electrical connectors.

*TRADEMARK

Bendix SCINTILLA DIVISION SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec.

FACTORY BRANCH OFFICES: Burbank, Calif.; Orlando, Florida; Chicago, Ill.; Teaneck, New Jersey; Dallas, Texas; Seattle, Washington; Washington, D. C.

ices for the heat-dissipation and supporting facilities.

Fallout Study

The General Advisory Committee to the U. S. Atomic Energy Commission recently reviewed the available facts and many opinions regarding the current magnitude of radioactive fallout and how much can be anticipated in the future from weapon tests that have already been carried out by the United States, the United Kingdom, and Soviet Russia.

The Committee found it is now apparent that the circulation of the upper atmosphere, and particularly the stratosphere, is much more complicated and the concentration of bomb debris less uniform than had been anticipated when early estimates were made. This has resulted in nonuniform distribution of the fallout with higher concentrations in the middle latitudes of the Northern Hemisphere.

Fortunately, it was here that most of the early measurements of actual fallout were made. The principal result of later information has been to reduce somewhat the earlier estimates of future fallout of debris which has been injected into the stratosphere near the Equator by the U. S. and U. K. tests. The debris injected last autumn by U.S.S.R. tests into the stratosphere in the more northerly latitudes has been falling out quite rapidly and is largely confined to the Northern Hemisphere.

The Committee stated that a reasonable estimate of the amount of fission products injected into the stratosphere by all nuclear tests is sixty-five megatons (TNT equivalent) of fission energy. This corresponds to about one hundred pounds of strontium 90 in the entire stratosphere. It is estimated that fully 50 per cent (50 pounds) of this strontium 90 has already fallen out. This means that not more than half of the total strontium 90 injected into the stratosphere still remains there.

The present state of knowledge does not permit a full evaluation of the biological effects of fallout. However, the Committee states, in order to place the hazard of fallout in proper perspective, it should be pointed out that the amount of total body external radiation resulting from fallout to date, together with future fallout in any part of the world from previous weapon tests, is: (a) less than five per cent as much as the average exposure to cosmic rays and other background radiation; and (b) less than five per cent of the estimated average radiation exposure of the American public to X-rays for medical purposes.

It is interesting to note that human beings have lived for many generations in parts of the world which have five times or more the background radiation normal to the United States, or more than one hundred times the average amount of radiation from fallout in the United States.

In regard to internal effects of strontium 90 due to ingestion, the amount of strontium 90 which has been found in food and water is less of a hazard than the amount of radium normally present in the public drinking water supply in certain places in the U. S.

Next, the Committee addressed itself to the question of the responsibilities of the Atomic Energy Commission with regard to radiation safety. Clearly, the Commission must assure itself that it is conducting its own operations in a safe manner, as is required by the Atomic Energy Acts. To meet these needs the AEC has established, in addition to worldwide sampling of air, soil, foods, and water, an effective and outstanding biological and medical research program in the general field of radiation hazards and protection. The AEC needs this program in order to have scientific facts available to ensure and improve the safety of its own operations. Therefore, the Committee recommends that the AEC continue its scientific studies in these areas.

target bearing 095°
...range 1,500...
speed—
270,000
m.p.h.!
Guided missiles of the future are on our scopes today—thanks to the agile brain of an amazing new ECM Simulator developed for the Air Force by Hallicrafters QRC.*
Designed for advanced study of jamming, deception and countermeasures techniques, the device furnishes to the PPI scope—via the radar's own antenna—exact simulations of moving targets, and jamming, in infinite variation.
Programming may be generated according to predetermined plan, or targets may be controlled manually. Speeds as fantastic as 270,000 m.p.h., as well as radical directional changes, now can be simulated for planning tomorrow's counter-measures.
ECM Simulator is another example of electronic design leadership that has made Hallicrafters a prime mover of key military projects for over 25 years.
Qualified engineers: new contracts have created openings. Contact William Frankart.
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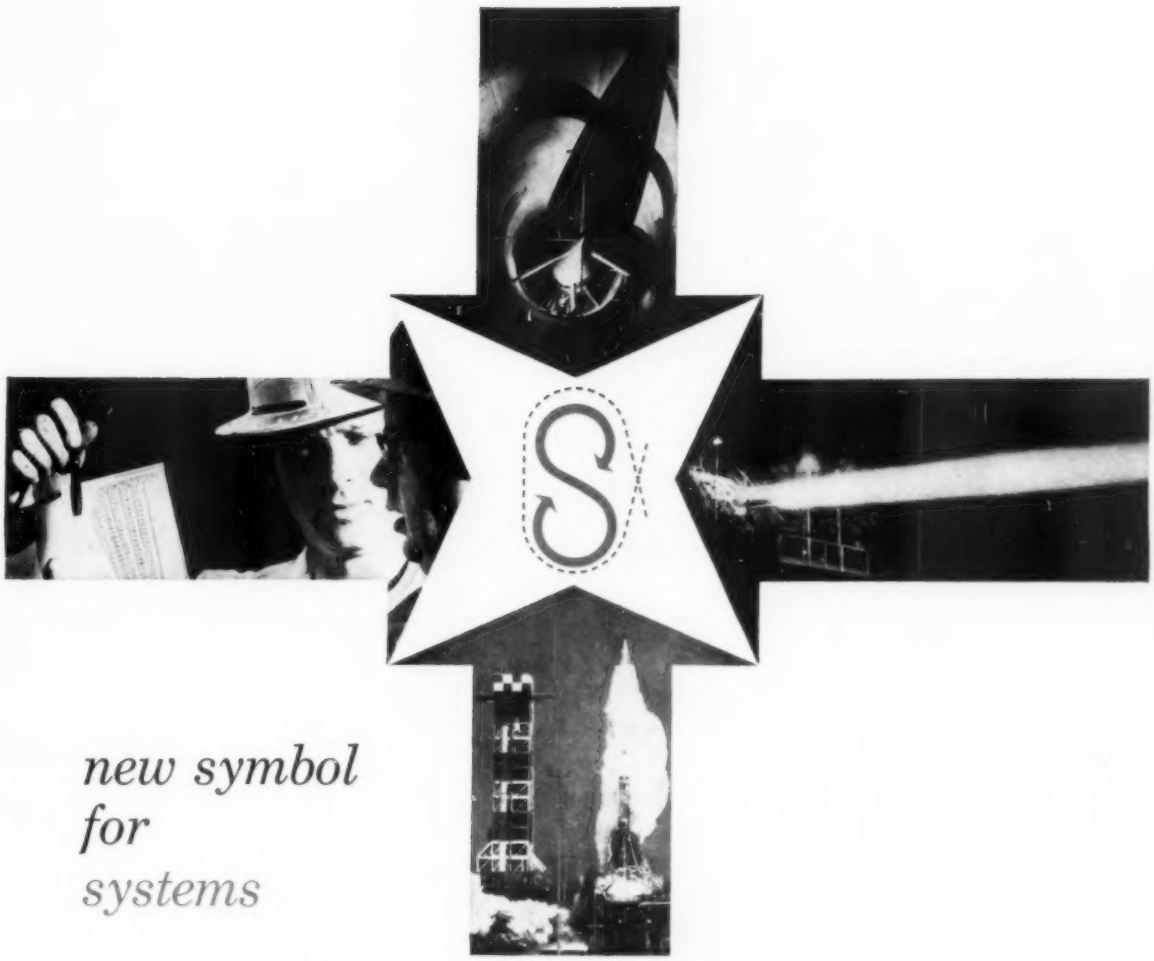
4401 West Fifth Avenue, Chicago, Illinois
*Quick Reaction Capability
Refer to Air Force Reg. #80-32



new symbol
for
systems

In five years of operation, Consolidated Systems has climbed from less than one-quarter million to over eight million dollars in custom-engineered systems for dynamic and static testing, chemical analysis, industrial control, and high-speed analog and digital data processing. This unprecedented growth in specialized systems (including missile ground support and cryogenics) is proof of quality – of performance – and of customer satisfaction. Over 500 systems have been designed, manufactured, and installed. These are *operating* systems producing data where time is critical and performance is paramount. Read about them in Bulletin CEC 1304-X52.

CONSOLIDATED SYSTEMS CORPORATION
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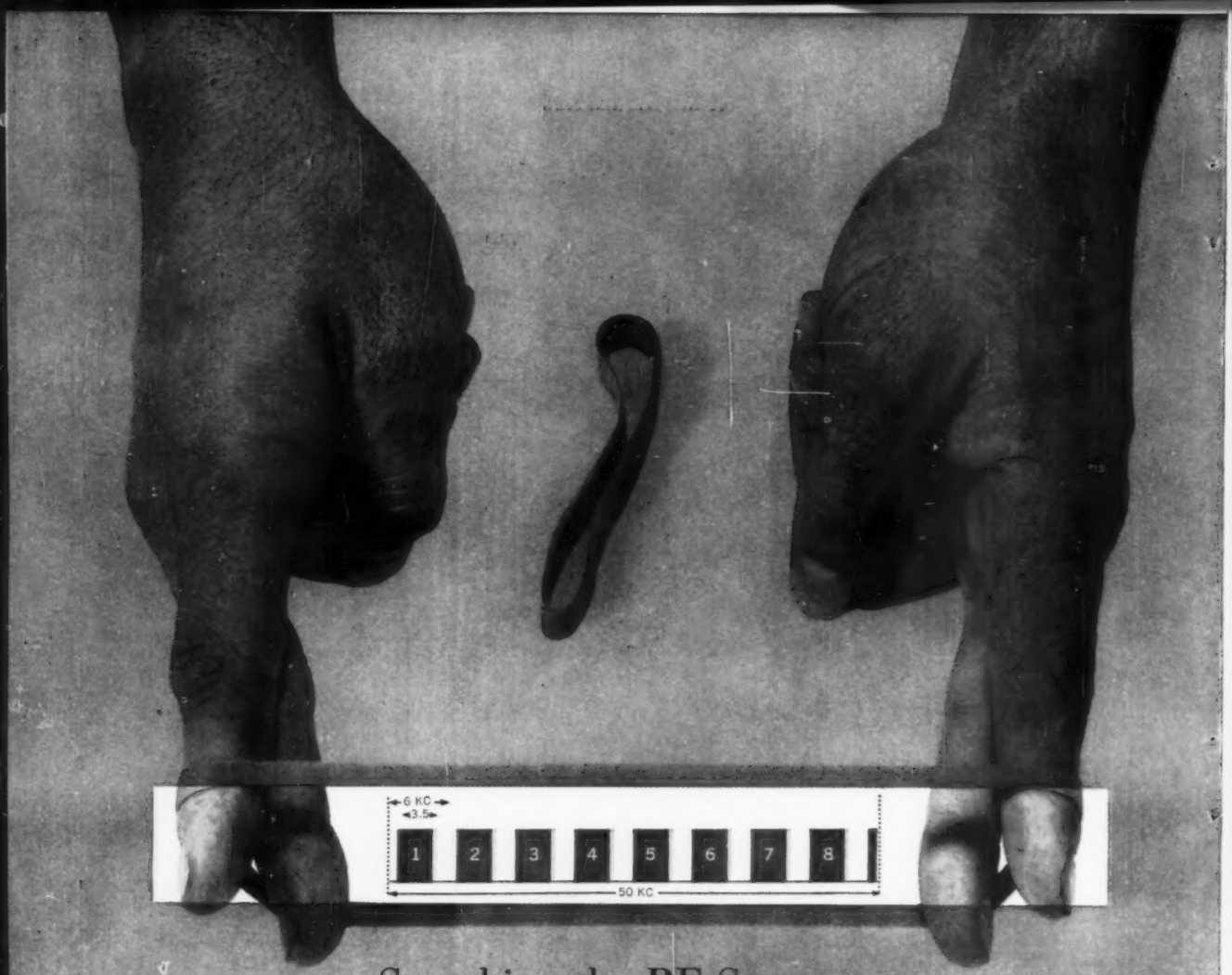


Stretching the RF Spectrum... with Motorola SSB

Modern tactical needs for multi-channel voice and data transmission create serious communication problems within the limitations of the inflexible spectrum.

As a step toward solving this wave-length tangle, Motorola design engineers have figuratively "expanded" the spectrum by reducing the per/channel requirements in advanced portable, mobile and airborne single sideband transceivers. The result is clear, continuous and simultaneous communication in air and surface surveillance, troop movement and air support.

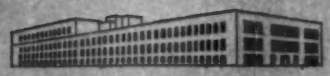
Motorola SSB transceivers incorporate the significant military advantages of being light in weight, compact in design. All employ these Motorola-pioneered contributions to effective communication: • Advanced application of transistors to communication equipment • Highly stable crystal oscillators • Refinements in crystal manufacturing techniques • Development and application of mechanical and crystal filters.

Motorola contracts with the three Services include pack-carried, mobile and airborne equipment.

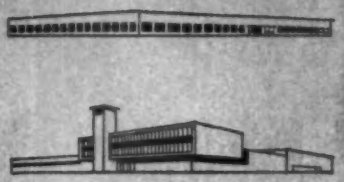
For information on these field-tested developments—or for data on engineering career opportunities—write to: Motorola Inc., Military Electronics Division, Dept. C, 8201 E. McDowell Road, Phoenix, Arizona.

MOTOROLA

Military Electronics Division / CHICAGO • PHOENIX • RIVERSIDE



CHICAGO



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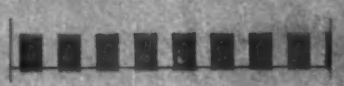


Expanding Motorola Facilities

Six Military Electronics Division plants in three locations... over 650,000 square feet of engineering and production space devoted exclusively to the design, development and manufacture of advanced military equipment.

MOTOROLA

Military Electronics Division

SPACE ARMAMENT

Astronaut Training

A program of training, indoctrination, and education has been drawn up for the seven Project Mercury astronauts to equip them with a wide range of technical knowledge and skills required to pilot the Nation's manned orbital capsule.

The initial phase of the astronaut program is broken down into six areas of activity:

1. *Education in the basic sciences.* Essentially an academic program, this area will include instruction in astronautics, basic aviation biology, space environment, astronomy, meteorology, astrophysics, and geography, including the techniques for making scientific observations in these areas.

2. *Familiarization with the conditions of space flight.* This phase of training is designed to familiarize the astronauts with the heat, pressure, G-force levels, and other special conditions of space flight. It will include periodic simulated flights in centrifuges and pressure chambers, weightless flying, training in human disorientation devices, the development of techniques to minimize the effects of vertigo, and experiments with high-heat environments.

3. *Training in the operation of the Mercury space vehicle.* The objective of this segment of the program is to provide a thorough knowledge of the Mercury vehicle and its functions, including the development of the skills required to control the capsule during flight, technical knowledge of boosters, propulsion systems and ballistics, and familiarization with the test range, tracking and recovery systems.

4. *Participation in the vehicle-development program.* Each of the astronauts will be assigned to a system or subsystem of the Mercury vehicle. In this work, he will acquire specialized knowledge of value to the entire group. This material will be exchanged in a series of informal seminars.

5. *Aviation flight training.* The Mercury astronauts will continue to maintain their proficiency in high-performance aircraft in an aviation flight training program. Continued operation of high-performance aircraft will give them additional altitude acclimatization, instrument flight training, and the physiology of high-altitude and high-speed flight.

6. *Integration of astronaut, ground-support, and launch-crew operation.* Familiarization with the operation of ground-support equipment and launch-crew operations will be accomplished in coordination with the agencies providing boosters and launch facilities.

Vega Satellite Launcher

In a $33.5 million contract, NASA recently named the Convair Astronautics Division of General Dynamics Corporation as prime contractor for Vega—a launching vehicle capable of putting a 5,000-pound satellite in an earth orbit.

Vega, which may be used as a 2-stage as well as a 3-stage vehicle, will be ready for test flights by late 1960. A 2-stage version should be capable of lofting a 2-ton space laboratory carrying several men in a 300-mile orbit for several weeks.

A third stage would be added for moon and planetary probes. A 3-stage Vega should be able to send a 1,000-pound payload to the vicinity of the moon and land several hundred pounds of instruments.

Vega will consist of a modified Atlas as a first stage, a second stage by Convair using a Vanguard booster engine, and a new third stage using storable fuel by NASA's Jet Propulsion Laboratory.

Fully loaded, Vega will weigh about 295,000 pounds and stand as high as a 10-story office building.

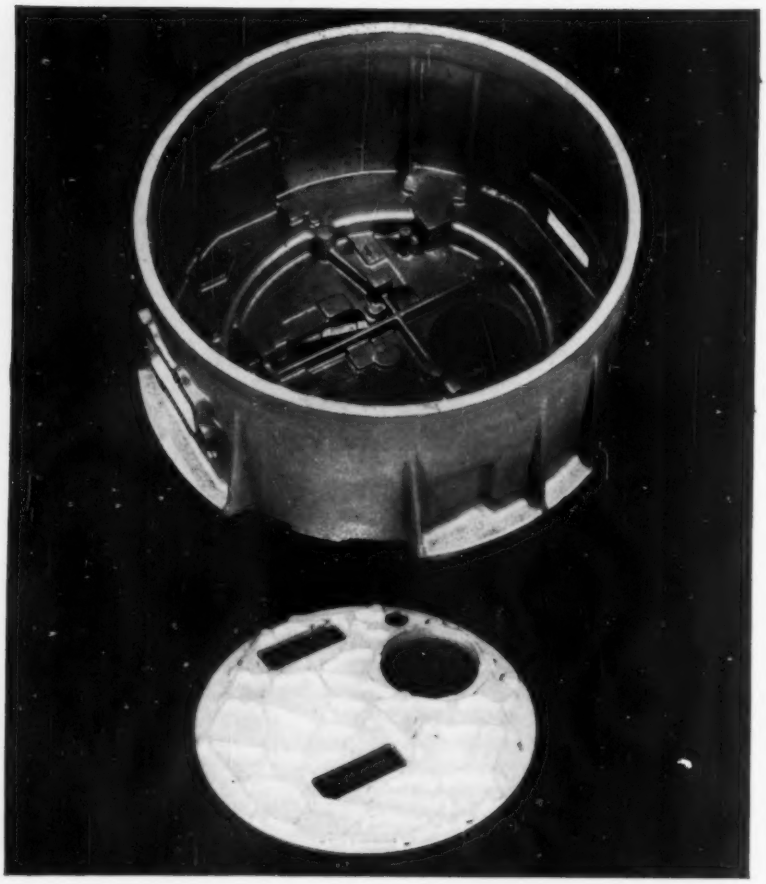
Guidance will be by autopilot in the second stage and inertial in the third stage with a system of jets to correct its flight path in space.

Project Saturn Engines

The first of eight liquid-propellant rocket engines which will provide the first-stage booster for the Advanced Research Projects Agency's Project Saturn, recently was delivered to Redstone Arsenal, Huntsville, Ala. Used in clusters of eight, the engines of the system will develop 1,500,000 pounds of thrust and will be 4 times more powerful than any other American flight-tested propulsion system.

The engine, a modification of existing Jupiter and Thor engines, was developed by Rocketdyne, a division of North American Aviation, Inc., under supervision of the Army Ballistic Missile Agency. ARPA had authorized ABMA to develop the system which will furnish the first-stage boost for the Saturn space vehicle.

DOW | MAGNESIUM PRODUCTS



K1A CASTINGS used on the Nike Hercules. Electronic guidance components are mounted on the die casting and housed within the sand casting. Dow is the production source for both castings.

NEW ALLOY DAMPS VIBRATIONS IN U.S. ARMY NIKE HERCULES

Dow plants cast a new lightweight magnesium alloy with superior damping capacity for electronic bases, housings.

Damping capacity—the ability of a material to reduce vibration by absorbing energy—is a highly important factor in electronic equipment used in missiles and aircraft. The performance of sensitive instruments can be severely affected by high energy vibrations generated in missiles in take-off and flight.

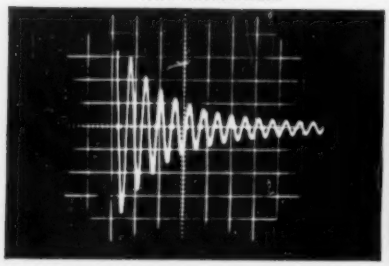
A big step forward in solving this increasingly critical problem is the development of K1A, a new magnesium alloy. Used in electronic bases and housings, this lightweight alloy eliminates complex mounting and suspension systems that often take up precious weight and space in missiles.

This new magnesium alloy has vibration damping characteristics much better than cast iron, aluminum or other magnesium alloys. Its heat conductivity and diffusivity are approximately twice that of standard magnesium alloys, thus making possible substantially reduced environmental temperatures for electronic instruments. Welding and machining have no adverse effect on the damping properties of K1A.

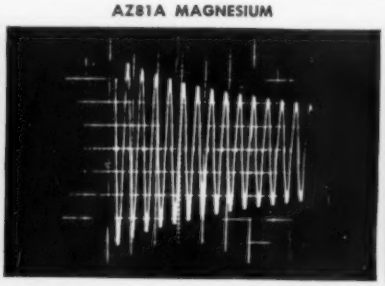
Bell Telephone Laboratories has done extensive work in determining properties and characteristics for the alloy, and in establishing its suitability for Western Electric's work on the guidance control system of the Nike Hercules. K1A is now available in the form of sand and die castings.

NEW BROCHURE on damping characteristics of magnesium discusses K1A, other Mg alloys. Contact the Dow sales office or THE DOW CHEMICAL COMPANY, Midland, Mich., Magnesium Products Sales Dept. 1313DF7-1.

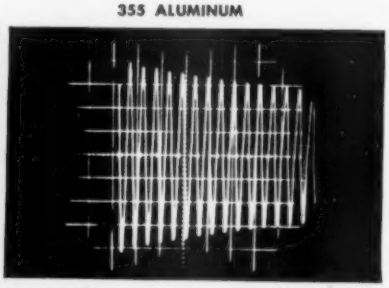
K1A MAGNESIUM



AZ81A MAGNESIUM



355 ALUMINUM



OSCILLOSCOPE PATTERNS, taken under identical test conditions, demonstrate high damping capacity of K1A compared to other magnesium and aluminum alloys. The superiority of K1A is evidenced by rapid absorption of energy as shown by the sudden reduction in amplitude of the vibration.

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

At the

TAPCO GROUP...

THE PEOPLE

THE FACILITIES

THE KNOW-HOW

to design and make systems, subsystems, and components

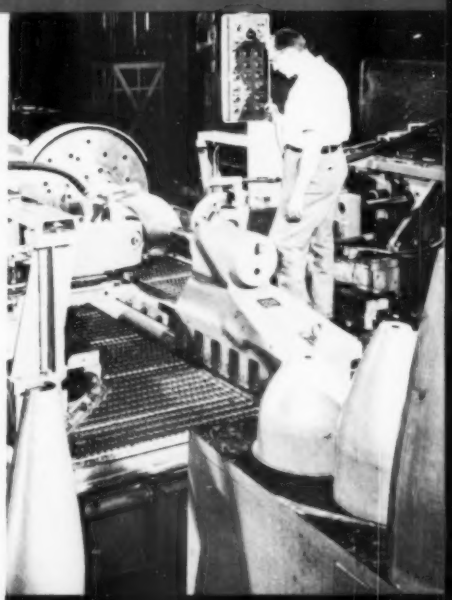
This 80-channel, 240-circuit analog computer in the TAPCO Group is able to speed the engineering of complex devices, can also simulate multiple-variant operating conditions for control systems.

AT TAPCO . . . 10,000 people combine every talent needed to create systems, subsystems, hardware

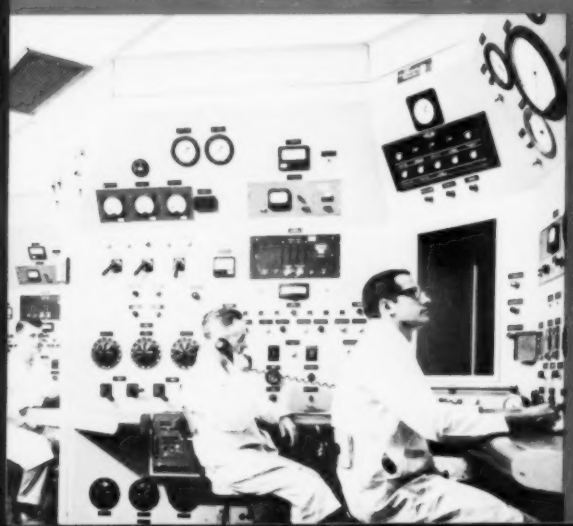
People at TAPCO . . . over 10,000 of them . . . are fully competent in the design and production of unusual rotating machines to handle fluids, electricity, and high-temperature gases. They have broad experience with unusual parts and structures requiring special resistance to shock, temperature, and corrosion . . . can produce components of all types in space-age metals and unusual alloys of common metals.

Development of unusual alloys and ways to fabricate them are nothing new to TAPCO people. More than 55 years of experience on metallurgical developments, fabrication and heat-treating methods, and unusual welding are available in the TAPCO Group.

Over one-third of the TAPCO Group people are engineers, with degrees covering every industrial science. They can quickly translate your idea for a vehicle, ground support unit, or system into a practical system, subsystem, or component.

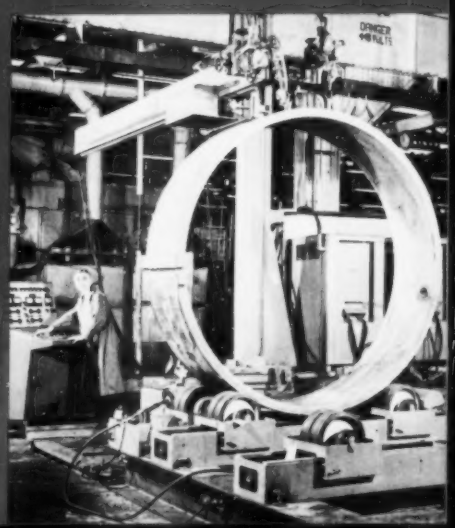


"Chipless machining" of special-alloy nose-cones for Bullpup air-to-surface missiles by hydrospinning, or roll-forming, at a high production rate in the TAPCO Group facilities.

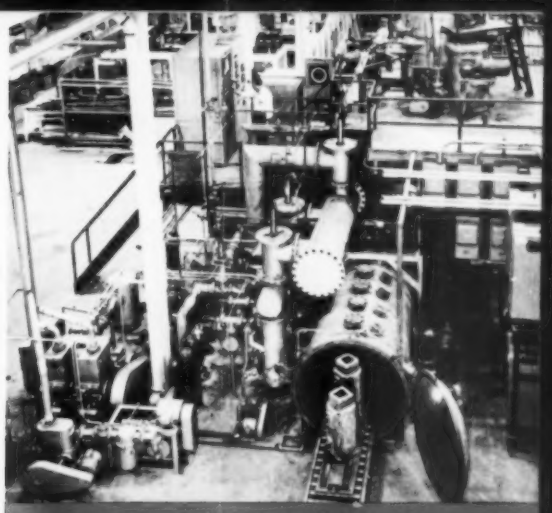


Complete facilities and manpower are available in the TAPCO Group for simulation, certification and pre-delivery testing of equipment built by TAPCO.

Positioning heavy stainless steel ring for submerged arc welding operation on a Herrick 10 x 12-foot automatic welder. One of many precision welding machines at the TAPCO plant.



Production testing of microwave components at the electronics facility of the TAPCO Group.



Vacuum-cast super-alloy ingots and precision investment castings are produced with facilities that include one of the largest induction vacuum furnaces—a 2,400-pound unit equipped for continuous charging, melting and pouring while maintaining evacuated atmospheres of 10 microns or less.

Facilities at TAPCO to turn unusual ideas into systems, subsystems, components

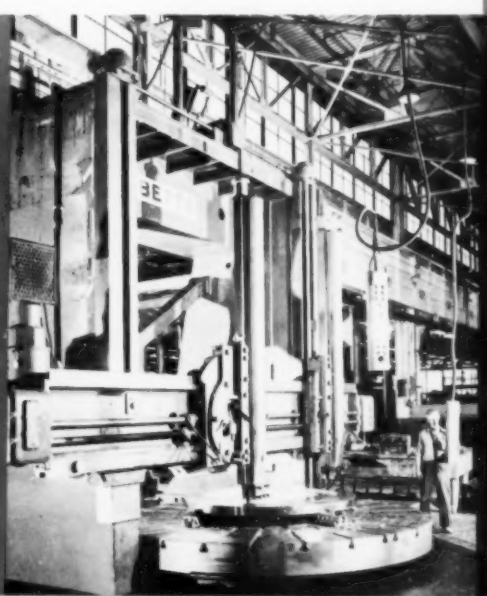
From conception to final delivery, TAPCO facilities provide for all phases of design, prototype, manufacture, and testing of a complete system, a subsystem, or major components of a system.

Research and development facilities within the TAPCO Group can process and interpret data for any problem, can simulate multi-variable conditions to govern test runs, can help reduce lead-time between original concept and final delivery.

The 11 plants within the TAPCO Group have 3,000,000 square feet of engineering and manufacturing area, half of it under one roof. Research and development equipment, production machinery and other facilities are valued at $150,000,000.

Optical jig mills in controlled atmosphere rooms at TAPCO are available for high-precision machining, as well as for the accurate inspection of dimensions and contours.

Newly installed at TAPCO, for machining large jet and missile engine cases and nuclear reactor structurals, this Betts boring mill can do highly precise, high-production turning, boring, and facing of pieces up to 144 inches in diameter, 120 inches in length.



TRW

TAPCO GROUP

Thompson Ramo Wooldridge Inc.

CLEVELAND 17, OHIO

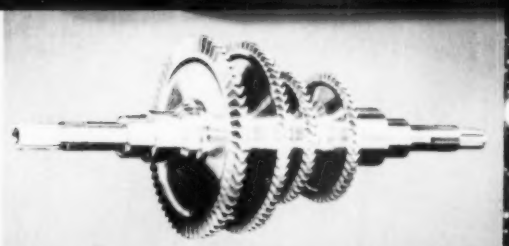
DESIGNERS AND MANUFACTURERS OF SYSTEMS, SUBSYSTEMS AND COMPONENTS FOR THE AIRCRAFT, MISSILE, ORDNANCE, ELECTRONIC, AND NUCLEAR INDUSTRIES

AT TAPCO, experience, ingenuity, creativity to solve your problems, develop your ideas

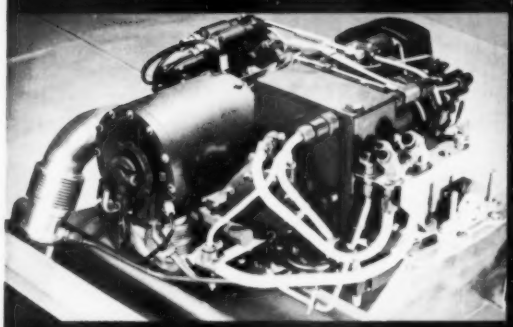
The TAPCO Group has a broad experience with the behavior of all types of fuels under all conditions, from ground level to highest altitudes. This experience has contributed to the design and production of over 1,100,000 aircraft and missile fuel pumps of all types.

Experience in the TAPCO Group also includes nuclear-reactor engineering, production of high-speed rotating machines to meet all temperature problems, and development and production of self-contained auxiliary power units of various sizes, duty-requirements, and configurations.

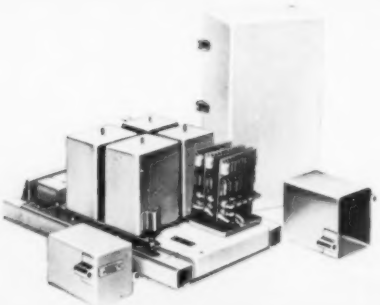
Let a TAPCO Group sales engineer explain how we can work with you to develop and deliver on-schedule any program or part of a program to meet your specifications.



Precision one-piece, four-stage turbine rotor for high-speed operation in auxiliary power units. Designed and manufactured at TAPCO.



APU developed and built by the TAPCO Group for use with exotic fuels. Testing was done under simulated operating conditions at TAPCO's 1100-acre Roanoke Test Facility.



Electronics equipment produced by the TAPCO Group includes wave guide switches, speed-sensing devices, microwave antennas and filters, computing systems, electro-pneumatic controls.

The TAPCO Group designed and supplied the entire roof structure, forward and aft doors, and actuating system for the Bomarc Model II missile shelters at the first operational sites at Eglin and Suffolk County Air Force bases. TAPCO also provided full field supervision to direct assembly and demonstrate functional operation.

TRW

TAPCO GROUP

Thompson Ramo Wooldridge Inc.

CLEVELAND 17, OHIO

DESIGNERS AND MANUFACTURERS OF SYSTEMS, SUBSYSTEMS AND COMPONENTS FOR THE AIRCRAFT, MISSILE, ORDNANCE, ELECTRONIC, AND NUCLEAR INDUSTRIES

AMERICAN ORDNANCE ASSOCIATION

Founded 1919

A patriotic, educational, scientific, nonpolitical, and nonprofit-making organization of American citizens dedicated to scientific and industrial preparedness for the common defense

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Harvey C. Knowles, Procter & Gamble Company, Cincinnati, Ohio
Henry T. Luria, Luria Engineering Co., New York, N. Y.
Henry N. Marsh, Wilmington, Del.
Daniel J. Martin, Hughes Tool Company, Houston, Tex.
Erle Martin, United Aircraft Corp., Windsor Locks, Conn.
R. L. Maxwell, Expansion Services, Inc., Washington, D. C.
James D. McIntyre, Montgomery, Ala.
Frederick H. Payne, Greenfield, Mass.
John S. Pfeil, Wellesley Hills, Mass.
Louis Polk, Sheffield Corporation, Dayton, Ohio, and Bendix Aviation Corporation, Detroit, Mich.
S. E. Skinner, General Motors Corporation, Detroit, Mich.
J. E. Trainer, Firestone Tire & Rubber Co., Akron, Ohio
Lysle A. Wood, Boeing Airplane Company, Seattle, Wash.

GEN. LYMAN L. LEMNITZER

Chief of Staff, United States Army

Military Leadership

The Army's new Chief of Staff follows a battle-proved tradition

WHEN a new military chief of any of our services takes office, the occasion affords an opportunity to review the achievements of the past and the responsibilities of the future. The recent change of military command in our Army at a time when public appreciation of the Army's importance is not as fervent as it should be makes the customary review especially important.

In saluting the new Chief of Staff and wishing him well, the occasion also can be utilized to stress the one factor which is essential in every military organization and particularly in our Army today. It is the priceless and essential place of leadership.

Our Army has been especially blessed in the quality and degree of its military leaders, not only in the important position of Chief of Staff, but in many of the subsidiary areas and at all levels.

LEAVING the distant past out of consideration for the moment, it can be said with complete truth that Army leadership since the Second World War has been notably virile, aggressive, and forthright. Each of our Chiefs of Staff, often against great odds, has not flinched in stressing the importance of the fighting man, his well-being, his morale, and the importance of the weapons with which he must defend himself and his cause. In our military annals the names of Bradley, Collins, Ridgway, and Taylor stand out as examples of conscientious devotion to duty, especially in upholding the need for adequacy of the Army to perform its mission.

Whether or not the Army has been equally successful in instilling the same fearless and attentive leadership throughout lower echelons is of deep concern. As important as the general officer is, it is the company officer, commissioned and noncommissioned upon whom rests the ability or inability to extract from his men the last full measure of devotion.

Gen. Maxwell D. Taylor, who has just relinquished office, is a notable example of leadership at its best. This he proved in battle time and time again. He demonstrated his prowess in the training of young men while he was Superintendent at West Point. Against great odds he battled to attain for the Army its rightful place in the present-day scheme of defense.

He did not hestiate to tell the people of our country through their chosen representatives in the Congress, with forthright and unflinching candor, the seriousness of the problems facing the Army, its inadequacy to meet the demands that are certain to be put upon it, and the error of allowing weapons of the future to replace—even before they are in existence—the conventional weapons which land armies must continue to rely upon in battle.

GENERAL Lemnitzer has inherited and has demonstrated all the qualifications to continue the type of leadership the Army needs so gravely at this time. He has been trained in the school of experience and has proved himself a capable and valiant officer. It is to be hoped that during his regime the pleas of his predecessors which have been neglected will finally be heard. By his skill, may our Army resume its rightful place, coequal with its sister services in national regard and in budgetary support. And may it be maintained in strength adequate to meet the worldwide land-warfare obligations which our country has assumed, but which it continually fails to face.

Gen. Lyman L. Lemnitzer, newly appointed Chief of Staff of the Army, is an officer of long experience and outstanding military service. He has filled key positions in tactical, strategic, and administrative assignments where his leadership was displayed in an exceptional way.

A native of Pennsylvania, General Lemnitzer was graduated from the United States Military Academy in 1920. In the following year he completed the course at the Coast Artillery School and was first assigned to the Coast Defense of Narragansett Bay and to other Coast Artillery stations.

After eight years he returned to the Military Academy as an instructor. Thereafter he was engaged in educational pursuits in the Army, either as student or teacher, at the Command and General Staff School at Fort Leavenworth, the Coast Artillery School, and the Army War College.

At the outset of the Second World War he was made Plans and Training Officer of the 38th Coast Artillery Brigade. Later he served on the War Department General Staff and at Headquarters, Army Ground Forces. He later served in Allied Forces Headquarters and in the Tunisian and Sicilian Campaigns.

Late in 1944 he was Deputy Chief of Staff to the Supreme Allied Commander, Mediterranean, and continued in that theater until war's end when he returned to Washington to become an Army member of the Joint Strategic Survey Committee of the Joint Chiefs of Staff.

General Lemnitzer's postwar service included command of the 7th Infantry Division in Korea, Commanding General of the Armed Forces in the Far East, and later Commander in Chief of the Far East Command and the United Nations Command.

He was named Vice Chief of Staff of the Army in April 1957 and succeeded Gen. Maxwell D. Taylor as Chief of Staff on July 1, 1959.

Air Power in Limited War

The Tactical Air Command's Composite Air Strike Forces are deployed and ready for immediate action in quenching any brush-fire conflicts or in complementing the deterrent power of our Strategic Air Command

Gen. Otto P. Weyland

WHEN a limited-war threat sprang up in the Middle East and again in the Taiwan Straits last year, it was once more readily evident that tactical air was one of the best means at our disposal to cope with the situation. If one examines the capabilities of the same force in a total-war role, the versatility and consequently the economy of tactical air power can be appreciated fully.

Following World War II, our overall force structure was developed primarily to deter a total war. In the event we fail in this end, we must be so disposed as to be able to survive a surprise Communist nuclear attack and strike back hard enough to win in the final outcome.

Today our greatest single deterrent to an all-out war is the large intercontinental bomber. However, the "big airplane" is not the sole solution to the total-war problem—it is far from the only means of waging such an air war.

Not long ago the big bomber was the only aircraft that could carry an atomic bomb. Now we have in our stockpile a family of smaller, more efficient weapons which can be delivered by tactical fighters. Now one tactical fighter has the striking power of an entire fleet of the bombers it escorted over Berlin during World War II. At the same time, it retains its inherent characteristics of survivability in the air, quick reaction, and the capability of seeking out and destroying the enemy's military forces whether they be mobile, hidden, or hardened.

General Weyland is Commander of the Tactical Air Command, United States Air Force, Langley Air Force Base, Va.

By striking close-in enemy counter-air installations, forward-deployed tactical air forces not only can clear the way for later penetration of SAC forces but also can lend a much-needed assist to U. S. and allied surface forces.

Over half of the U.S.A.F.'s tactical air units are permanently based in the European theater and the Far East in close proximity to Communist front lines. In addition, several U. S. based TAC squadrons are maintained continuously overseas on rotation. Before one squadron returns to its home base in the U. S., another squadron from the same wing is dispatched to the overseas operating base to take its place.

Our overseas-based tactical forces are backed up by TAC wings in the States which have predetermined deployment sites and wartime targets. By virtue of their mobility with in-flight refueling, these U. S.-based TAC wings are actually combat-ready forces echeloned in depth for security and flexibility.

Because of their advantageous position, mobility, and immediate availability, these U. S.-based wings are a logical source of our limited-war deterrent. Squadrons from these wings made up the TAC Composite Air Strike Forces (CASF) which were deployed to Turkey and to the Far East last year.

All overseas-based tactical units maintain a certain number of fully armed aircraft on ready alert. Their pilots are standing by with detailed informa-

Air Force photo

tion on preselected targets which fit into the over-all general war plan. By reason of his proximity to the target and quick reaction time, the tactical fighter pilot can hit its target minutes ahead of overseas-based SAC units and hours ahead of U. S.-based SAC units.

For a number of reasons I firmly believe that the tactical fighter has better odds of penetrating enemy air defenses and destroying its target than any other aircraft in the inventory. First of all it presents a relatively small radar return and is consequently extremely difficult to detect. If detected, it is equally difficult to intercept because of its superior performance. If intercepted, it has an excellent chance of fighting its way through to the target.

The economy of a single or twin-engine fighter versus the 4- to 6-engine bomber for targets within range of secure bases requires no elaboration.

Whereas total war constitutes the most serious threat to our security, there remains the possibility of armed conflict of the limited variety. The unquestionable success of U.S.A.F. strategic air power as a deterrent to total war has inevitably led the Soviets to concentrate on expansion of satellite areas as a complement to safer politico-economic pressures. If we ignore these Communist-inspired efforts we may lose another area of the world to the Soviets.

This is why we must take every reasonable action to deter a small war before it starts or neutralize the Communist-backed activity if it is already under way. The retention of the long-time friendship, trade, and support of Communist-bordered countries is directly related to their confidence in our direct support in preventing the Communists from overrunning their homelands.

There are certain elementary considerations in designing a force which is adaptable to deter or fight a small war as well as a big one. First, since we can hope to receive but little advance warning of an impending conflict, such a force must be able to react quickly and arrive at the scene before the fire kindles. Nothing is more reassuring to a beleaguered ally than the visible presence of U. S. forces in the threatened area.

In this regard the Communists made a mistake in picking Korea for their first experiment in limited war, for near by we had Army, Navy, and Air units readily available to throw into the breach. I suspect that this lesson was not lost on them, and that we can count on future limited aggressions commencing in more remote areas.

Secondly, the force must be versatile and flexible; *i.e.*, capable of performing a variety of missions and delivering a wide range of ordnance. The air component of this force must be a miniature Air Force for we could not long afford to send out a World War II size package of air power every time the Communists create a crisis somewhere in the world.

For obvious economic, political, and psychological reasons we must be capable of delivering weapons carefully tailored for the job at hand. Depending on many factors, this might be 20-mm. cannon, napalm, rockets, nonatomic

bombs, or tactical atomic weapons. I must emphasize that tactical A-weapons are not weapons of mass destruction, but rather are relatively low yield, highly efficient bombs specifically designed to destroy military targets with minimum damage to surrounding areas.

I vividly remember during the Korean war the tremendous number of high-explosive bombs our B-29's rained on the bridge over the Han River leading into Seoul. One low-yield atomic weapon delivered by a tactical fighter using the low-altitude technique would have destroyed that bridge with, in the final analysis, less damage to the surrounding area.

Thirdly, such a force must be reasonably self-supporting. Our limited-war-deterrent force should arrive with sufficient support personnel, equipment, and spare parts to operate independently for about thirty days, or until follow-on logistical support can take over.

The Strategic Air Command and Air Defense Command are dedicated as total-war deterrents, and their postures, armament, and concepts of operation are designed for total-war situations. SAC forces are not designed or suited to carry out many of the tactical missions associated with a limited war.

Although they represent important back-up forces and serve to prevent the small war from expanding into a total war, SAC forces and theater tactical forces should not become directly involved in a small war for that would jeopardize their total-war-deterrent posture.

CONSEQUENTLY tactical air power —and the Tactical Air Command specifically—must be the ready and mobile deterrent and comprises the operating air force for limited war.

We in TAC started preparing for this role in earnest shortly after the Korean war ended, for I was determined to improve our posture and capabilities to assist in coping with new "Koreas." At this point, the Composite Air Strike Forces concept was born.

Prior to this, TAC units in the U. S. were primarily devoted to training and reenforcing theater forces. Therefore they represented a pool of combat-ready air units which, with in-flight refueling, could be deployed to almost any threatened area in the world in a matter of hours.

Tactical units permanently based overseas were excluded from consideration since they were inexorably committed to total-war targets. To shift them into a limited-war area would disturb our total-war posture at a time when the total-war threat was the greatest.

Certain combat-ready units are earmarked for Composite Air Strike Forces operations. They are given the highest priority available in TAC and kept in a constant state of readiness. The equipment and spare parts they need to operate for thirty days away from home are retained in "fly-away" kits, packaged and fully identified for loading aboard transport aircraft in double-quick time.

A unique feature of the CASF concept is its command element. Within TAC we have formed a numbered (Nineteenth) Air Force headquarters, composed of approximately fifty planners and operations and communications specialists. This nucleus of limited-war experts plans in detail for contingencies short of total war, including deployment routes, airfields and prepositioned supplies, targets and force requirements for each potential limited-war area.

In addition, personnel of this headquarters are on the same degree of alert as the tactical units earmarked for the CASF. Once given the green light, they would immediately proceed by air to the scene and take over command of the CASF committed tactical units as they arrive at their destination.

In an area where a joint or unified command has already been established, the CASF commander would be under the command jurisdiction of the joint or specified commander.

While we have exercised the CASF concept many times during the past five years, it was not formally baptized until the Lebanon flare-up last summer.

When President Chamoun called on our Government for help, a CASF was sent to an airbase at Adana, Turkey. The force, made up of roughly 100 aircraft, including F-100 tactical fighters, B-57 tactical bombers, RF-101 and RB-66 reconnaissance aircraft, C-130 transports, and KB-50 aerial tankers, was in place in less than forty-eight hours after the go-ahead was given in the U. S. Some of the F-100's made the trip nonstop from Myrtle Beach Air Force Base, S. C., to Adana in less than 13 hours.

Perhaps the best measure of the success of the operation was the very fact that the force was never required to fire a shot or drop a bomb. I am certain that its presence along with combat elements of our sister services in the early stages of the crisis discouraged the Communists from starting a shooting war.

WHILE this CASF under the Nineteenth Air Force was still at Adana, TAC was called on to send a second CASF to the Far East to reenforce theater air forces during the Taiwan Straits crisis. A force comparable to the Adana CASF arrived at its destination bases in the Philippines, Okinawa, and Taiwan seventy-two hours after receiving the deployment order.

Again, other than some sporadic air encounters between Chinats and Chicoms and steady shelling by the Communists of the off-shore islands, the threat of a dangerous limited war faded away with the arrival of American forces.

The CASF concept as a limited-war deterrent has twice been given the acid test and on both occasions proved its mettle. It is a vital element of the an-

"I firmly believe that the tactical fighter has better odds of penetrating enemy air defenses and destroying its target than any other aircraft in the inventory.

"First of all it presents a relatively small radar return and is consequently extremely difficult to detect. If detected, it is equally difficult to intercept because of its superior performance. If intercepted, it has an excellent chance of fighting its way through to the target."

swer to the limited-war threat—one that we could ill afford to lose.

With the advent of the IRBM and the ICBM there has naturally been a rather heavy reduction in manned aircraft in the U.S.A.F. Unfortunately, TAC has borne the brunt of most of the cutbacks. In the past two years eight TAC wings, roughly half our force, have been deactivated. This has cut TAC's capability to the point where any further reduction would seriously hamper its ability to perform its varied total, limited, and cold war missions.

Although tactical air forces have been able to meet all their commitments, the pinch of obsolete equipment is beginning to be felt. Worldwide there are only thirty-one tactical wings at the present time. By anyone's standard this represents a rock-bottom figure.

Our tactical fighter strength is basically made up of the North American F-100. Although the F-101, F-104, and F-105 are more advanced and efficient aircraft, we have been able to afford only one wing of each of them. It appears that for a good many years in the future the rapidly aging F-100 will be the mainstay of our tactical air forces, although there are tactical fighters flying today that have twice its speed and other more desirable characteristics, such as additional range and all-weather bombing and navigation systems.

THE TAC tanker problem is immediately acute. At present we are operating KB-50 tankers—retired SAC bombers which have been converted to our use. This is a "make-do" philosophy which is excellent in principle, but marginal in practice. We modified these aircraft to convert them to tankers and later added two jet engines in order to boost their speed and altitude to minimum operational limits. Even with this added tanker performance, we are unable to deploy our CASF in weather where refueling must take place at altitudes much above 20,000 feet. Such a limitation could become our "Achilles heel."

Also there is a valid future TAC requirement for an aircraft with vertical take-off (VTOL) or short take-off and landing (STOL) characteristics. Little money is being invested at the present time for adequate research in this area. Yet even in the missile age many aviation experts are well aware of the requirement for such aircraft as a complement to the missile.

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"I vividly remember during the Korean war the tremendous number of high-explosive bombs our B-29's rained on the bridge over the Han River . . . One low-yield atomic weapon delivered by a tactical fighter . . . would have destroyed that bridge."

We need VTOL and STOL aircraft to eliminate the necessity for long runways in overseas areas where we must maintain adequate deterrent forces on the fringe areas of the Communist world. Such aircraft can be installed in "hardened" shelters capable of surviving atomic attacks, thus posing a real threat to an aggressor right in his own back yard.

These are basic facts that have a bearing on our over-all capability to resist aggression in both general and limited wars. If it is necessary to re-evaluate the role of tactical aircraft as a deterrent weapon, then I believe that time has come.

No article on tactical airpower would be complete without comment on TAC-AIR's close liaison with U. S. and friendly surface forces. During World War II and Korea, tactical air force personnel worked side by side with their Army counterparts and created the conditions which permitted surface forces to go into battle with the greatest chance of success over the enemy.

Today our tactical forces are still fully qualified to carry out their traditional tasks in the land-air battle: tactical reconnaissance, gaining air superiority, interdiction of enemy forces and supplies, and close support of friendly ground forces.

Contrary to some opinion, the jet fighter is actually better qualified than its propeller-driven predecessor in the close-support role. The jet is a more stable gunnery and bombing platform and therefore more accurate. Also, as we learned in Korea, the jet engine will take considerably more punishment from small arms or antiaircraft fire than the piston engine.

Above all, the jet fighter can live in the air where in this day and age even the most efficient prop or turboprop model is easy prey for enemy jets.

AN area of recurring concern on the part of our Army counterparts is the business of airlift. Briefly, here is the air-transport capability as it exists today.

TAC, the U. S.-based Air Force command charged with tactical airlift, possesses two wings of C-130's and five squadrons of C-123's. Medium and assault troop carrier transports are also assigned to our tactical air forces in Europe and the Pacific. In addition, there are fifteen wings of Air Force Reserve C-119's with wartime assignments with TAC.

All these units are specialists in airlifting airborne troops into battle and resupplying them until they are joined up by other surface forces.

MATS has primary responsibility for the long-range, or strategic, movement of ground forces by air. In this mission, the MATS aircraft can be supplemented by TAC's C-130's and by aircraft of the Civil Reserve fleet.

This then is the TAC story—its missions and its capabilities: an economical and powerful offensive complement to our strategic air power in all-out war; a quick-reacting, mobile, and flexible force to help deter or fight limited conflicts. It is that element of the Air Force which works most closely with U. S. and allied surface forces in joint operations in the field.

It is certainly a most versatile, relatively economical force which plays a vitally important part in backing up U. S. policy and in guaranteeing the security of our Nation.

The Polaris Missile

Teamed with the long-range, high-speed, nuclear-powered submarine the solid-fueled missile can be fired against any hostile target and should act as a powerful deterrent to an all-out conflict

Rear Adm. W. F. Raborn

IT is no secret that in World War II both sides held in readiness weapons which used lethal gases as their medium of destruction. Some of these gases, like the A-bomb and the H-bomb were weapons capable of wiping out whole areas, though not on quite the same scale. Yet Hitler, in all his desperation, when morality or human decency were no longer elements in his actions, never gave the order to start the exchange of poison gas. He knew that he, along with countless thousands, would be numbered among its victims.

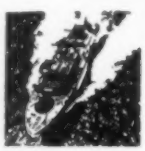
The awesome arithmetic of nuclear warfare deals in destruction on a scale beyond our capacity to imagine. No one really knows what might happen once the nuclear exchange is started. No one knows how far it might go. No one knows how much of a fragment of our world it might leave. All the studies that have been made, all the articles that have been written, and all the speeches that have been delivered rest on estimate and assumption and conjecture.

THE fact that emerges in sharper and sharper focus, however, and the one on which there can be no disagreement among sane men, is that our big job is to make sure that such a catastrophe never takes place.

At some time, we hope soon, we can work out some form of living on the same planet without the threat of mutual extermination. There's precedent for this, too. It was some centuries before the bloody Crusades and religious wars convinced Christians and Moslems that they could share the resources of the earth and leave each other's concepts of worship alone. Although there are frictions today, they are political and not religious in character.

Admiral Raborn is Director of the Special Projects Division, Bureau of Ordnance, United States Navy, Washington, D.C.

In the meantime, while we hope that statesmanship can provide "insurance" against our annihilation, the deterrent weapons branch of our armed forces has no choice but to make certain that we back up this protection as fully as possible.



As of now, we have a wide variety of "deterrent" jobs to do, not only to prevent all-out nuclear attack on the free world, but to prevent any and every degree of aggression, wherever it might crop up. Never before has our country needed a navy, needed sea power in being, as acutely as it does today.

We have seen, very recently, just what it means to us to have such control of critical waters. No one will forget the effect of the landing of our Marines on the beaches of Lebanon on something like forty hours' notice when the Lebanese Government asked our aid, nor the sobering influence of our carriers and cruisers offshore.

Recent history is studded with "crises" which called for our naval forces right at the scene of trouble to exert effective and timely deterrent "persuasion" on those who might be tempted to military adventures. There are no signs that the so-called "cold" war will be called off, and every sign points to continued pressures to keep us off balance economically, militarily, and in our relations with our friends and allies. Thus, our Navy faces more jobs, in greater variety, in more places, and with more immediate impact on world history than any navy ever assembled.

The Navy has still another very highly specialized job of "deterring" to do, and that is to counter any possible moves of the world's newest navy—the fast-growing fleet of the Soviets. This is a navy unique in one repect—it includes the largest fleet of submarines ever envisioned. Most of them are new, just as most of the rest of the Soviet fleet is new.

This navy is neither a gesture nor a façade. It has been carefully planned with one world power in mind—us. It is the second most powerful navy in the world. It is strong not only in its tonnage, but in its organization and

training. It is constantly drilling, constantly flexing its muscles. It is a navy which we must treat with the respect it deserves.

If our own Navy had no other job to do than to checkmate the new Soviet fleet, especially the 2-ocean threat of its 500 or more submarines, our Navy would more than earn its keep.

To meet this threat we maintain powerful carrier-destroyer-aircraft teams as well as special antisubmarine submarines. We have developed new weapons of great range and uncanny accuracy. We have set up warning systems along both our coast lines. Yet we have no illusions about the difficulty of the job to be done nor of its tremendous importance to our national safety.

THE backbone of our immediate deterrent naval power in terms of preventing nuclear attack is, of course, our swift and heavily armed carrier striking forces in the Atlantic, the Mediterranean and the Pacific. These mighty ships share with the great air fleets of the Strategic Air Command the daily responsibility of posing our own nuclear threat, of providing us with the one international voice that will be heard with respect beyond the Iron and Bamboo Curtains.

But the United States must look ahead to the era when new weapons will take over much of the responsibility for providing the nuclear deterrent which makes the terms "aggression" and "suicide" virtually synonymous. The Polaris program occupies a very special and individual place in our national plans for developing systems of long-range, high-speed vehicles for delivering nuclear warheads.

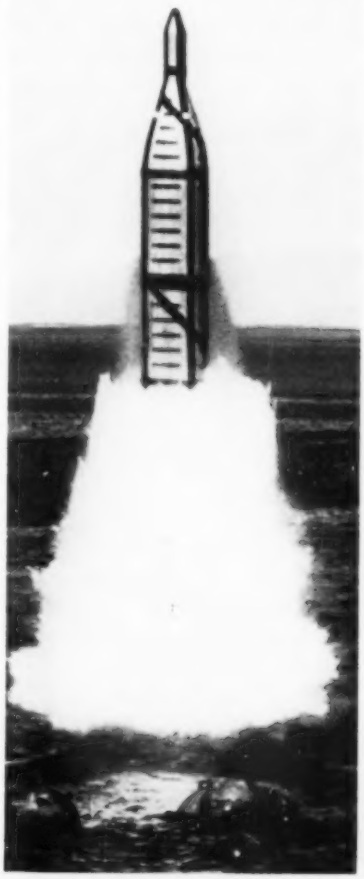
The Polaris is a weapon system which combines both potential applications of the newly awakened source of energy—the atom. Not only does it draw on the technology of nuclear destruction, but it also draws equally on the expanding field of nuclear power for constructive purposes.

IN the warhead the grim objective is to pack as much utter destruction and accuracy as human ingenuity can develop. In the power plant of the carrying vessel, the atomic submarine, the same knowledge and skill and resourcefulness have been applied to creating an engine of virtually inexhaustible endurance, to unfettering a power-driven ship from its need to renew its fuel at frequent intervals. For once, ships can be independent, to all intents and purposes, of bases, tankers, fueling stations, and even the production of black oil.

The achievements of the NAUTILUS, the SKATE, and the SEAWOLF have underscored how successfully technology has met the problems of operating in areas never before invaded, of long-distance voyages at submerged high speeds and of the physical abilities to remain in the ocean depths for weeks at a time. It is my hope that these achievements soon can be directed to uses of peace and that nuclear-energy power plants can work to serve mankind rather than contribute to plans for its destruction.

From the military angle, the nuclear submarines' resounding success as a practical, operational reality has cleared the way for a unique weapon system in our deterrent program. It has provided us with a highly mobile and self-sufficient "base" from which to launch nuclear warheads—not only from positions far distant from the target but also from positions providing the utmost degree of concealment.

Polaris test missile rises from water.



POLARIS-EQUIPPED nuclear submarines might prowl the depths of the ocean for months at a stretch, patrolling within range of any enemy's vital targets, moving constantly and at high speed, if necessary. They would be virtually impossible to locate without the most extensive effort and facilities, dispersing the enemy's defensive forces over literally millions of cubic miles of ocean. Even then it is unlikely that most or all of such an underseas threat could be detected and destroyed by any means so far developed or in sight.

Being constantly under way, and moving from one position to another, no potential aggressor could "zero in" such targets for attention and destruction by surprise attack. He would be faced with the choice of accepting the retaliatory annihilation of their long-range weapons or of tracking down and destroying them in advance, much as one might have to clear an area of rattlesnakes before pitching a camp. And if they started doing that, they would most certainly tip their hand as to their aggressive intentions. As one strategist expressed it, "Polaris carries a built-in early warning system."

THE atomic-powered submarine provided our missile program with a unique kind of launching base to supplement the other needed categories of facilities for launching ballistic missiles and offered the possibility of adding greatly to the strength of the entire program. Then the Navy had to find some way of providing the missiles, the launching equipment, the underseas navigation required, and communication with the source of command.

These are a lot simpler to enumerate than to provide. In each case it was necessary to achieve major technical break-throughs to solve wholly new and unique problems.

In the development of the missile itself, two vital technical frontiers had to be crossed before the Polaris program could enter the realm of an operational possibility. One was contributed by the Atomic Energy Commission, whose able scientists came up with a nuclear warhead powerful enough to do the job required of it and yet small and light and compact enough to fit the confined spaces of a submarine.

The other was a Navy achievement, of which we all can be very proud. This was the successful development of a solid fuel as the rocket propellant, for the highly volatile liquid fuel used in land-launched rockets was just not practical for submarines. The end result was a new type of ballistic missile, so compact that a very respectable number of them can be carried in a submarine of roughly conventional dimensions, providing an awesome battery of weapons.

When fully developed, the Polaris weapon system will provide a highly significant supplement to our land-based intercontinental and intermediate-range ballistic missiles. While Polaris possesses the range of the latter, (about 1,500 miles) it possesses also some of the characteristics of the former, with its intercontinental carrying power. This is very simple to explain. A 5,000-mile range makes it possible to launch a missile from our own soil and reach virtually any target area that strategic plans might call for. That is, we can build and operate these launching bases without obtaining the consent of any foreign government.

WITH Polaris we can achieve the same result, but we move the "American-flag base" nearer the targets, into waters within 1,500-mile range of these targets—waters within the jurisdiction of no nation as they are part of the open sea which covers three-quarters of our planet.

From the practical standpoint, we have the full control of our launching bases, as in the case of the ICBM, yet the targets are within 1,500 miles, as in the case of the IRBM, offering the advantage of moving the launch sites away from our shores.

The Polaris weapon system forms an element in a carefully thought out team of deterrent weapons. It does not conflict with the functions of other missile programs but fills a specific gap which we should not leave unfilled. There is a very real team effort in the development of all our rocket and missile projects, whether these be in the purely scientific field or in that of military weaponry.

The Polaris program has drawn on know-how from both the other armed services and has, in turn, contributed its full share to the over-all ballistic-missile progress of our defense program.

As of today, when Polaris is mentioned, three very simple and very blunt questions must be answered: "Will it work?" "When will it be ready?" "How much will it cost?"

At this stage in its development, the first question can be answered with an unqualified and emphatic "Yes." We have every reason to believe that the technical barriers have been surmounted and that the remaining problems are those of engineering and refinement.

For some months we have been conducting firings of so-called "test vehicles" for a variety of purposes. Recently we launched two full-sized missiles, both of which had to be destroyed as a safety measure.

However we learned from these tests that certain elements—the critical ones—proved the soundness of their design. The components which caused the failures were relatively minor ones and can be corrected by reengineering certain features. Many of the firing tests have been most successful and have proved beyond any doubt that the solid-propellant fuel is a practical reality.

No new weapon, especially no device as complex and revolutionary as a a missile that can travel at speeds up to 10,000 miles an hour, reach a target 1,500 miles distant, and hit it, can be developed without extensive tests and refinement and training in its use.

We are by no means discouraged. We are, in fact, reassured that the most difficult technical problems are behind us. We are, it might be added, well ahead of our development schedule.

One problem is that of shooting a big piece of ordnance out of a submarine deep below the surface and up into the air where its rockets can ignite. To develop this technique we built two items of equipment. First, the "Pea-shooter," for firing dummy missiles from a position on land. After many test shots, we moved to the next item, an underwater launching device, the "Pop-up."

Another problem was that of launching a missile from a submarine in motion, for even submerged and with its engines stopped, there is quite a bit of movement at the time of launching—enough, at least, to create a complex technical problem. To overcome this we designed a highly intriguing device called a "ship's motion simulator" which mechanically duplicates any type or degree of a ship's motion. This permits exhausive tests on dry land in launching a missile under almost any conceivable operating condition afloat.

AFTER these tests, there will be further tests in launching missiles from a specially converted Mariner-type merchant ship, recently commissioned. This ship will be a permanent part of the project as a training vessel after the test periods have been completed.

There also was a navigational hurdle to clear before we could have an operational weapon system in Polaris. When you are shooting at a target 1,500 or so miles away, the slightest error in direction and range can be extremely serious. You must aim the missile with extreme accuracy, and to do this you must, obviously, know just where *you* are at the time of launching.

On land this is comparatively simple. But deep below the surface it is quite a different matter, especially if concealment demands that you stay down below and don't come to the surface to take sights of the sun or the stars.

Wholly and basically new and far more accurate methods of navigation

had to be developed to meet this problem. That they are well in hand was demonstrated dramatically not long ago by the submarine voyages under the North Pole which put the new methods to very practical and exacting test.

For nearly two years we have had in service a special navigational development ship, the U.S.S. COMPASS ISLAND, permitting us to develop, refine, and test all the many items of navigational equipment which had to be created as part of the Polaris project.

WE have another problem not shared to anywhere near the same degree by our colleagues on land, and that is the extremely critical matter of telling a submerged submarine, perhaps thousands of miles distant, what targets to shoot at and when to fire. That is, of course, the problem of operational communications between the center of command and the operating missile-launching submarines. In this area, too, we have had to deliver a few technical advances.

The question of "When" is, broadly speaking, highly classified. This same question of "When" is also a matter of clarification as to what is asked. There is a world of difference between firing a missile successfully in a test and having an operational weapon system deployed where it can exert its intended deterrent influence.

The first actual missile firings afloat will be conducted soon, and present timetables call for operational submarines, on station, some two years sooner than originally was thought possible. Some of these submarines are actually under construction; others are to be started very soon. If present schedules can in any way be speeded up, this will be done.

In any question of time factors, it must be borne in mind that we are dealing with matériel radically new in its basic functions. We are not dealing with refinement of existing weapons—we are most literally entering a wholly new field, the vast vacuum of unprobed outer space in which ninety-five per cent of the flight of a long-range ballistic missile takes place. Here entirely new rules apply and must be learned.

We are dealing in a new arithmetic of weaponry. Some ballistic missiles are much larger than an upended pullman car. They travel faster than any weapons ever conceived—ten to fifteen thousand miles an hour. They travel far greater distances than any weapon ever created before, distances measured in thousands of miles, not thousands of yards as in the case of artillery. They are more complex than any weapons ever designed, some of them having several hundred thousand individual parts.

Finally, such weapons are more destructive than any ever dreamed of in all history. In its very numbers, as such, the arithmetic is new. No longer need there be, as in World War II, hundreds or thousands of bombs per major target. It is now *one* bomb per target, or a few at most.

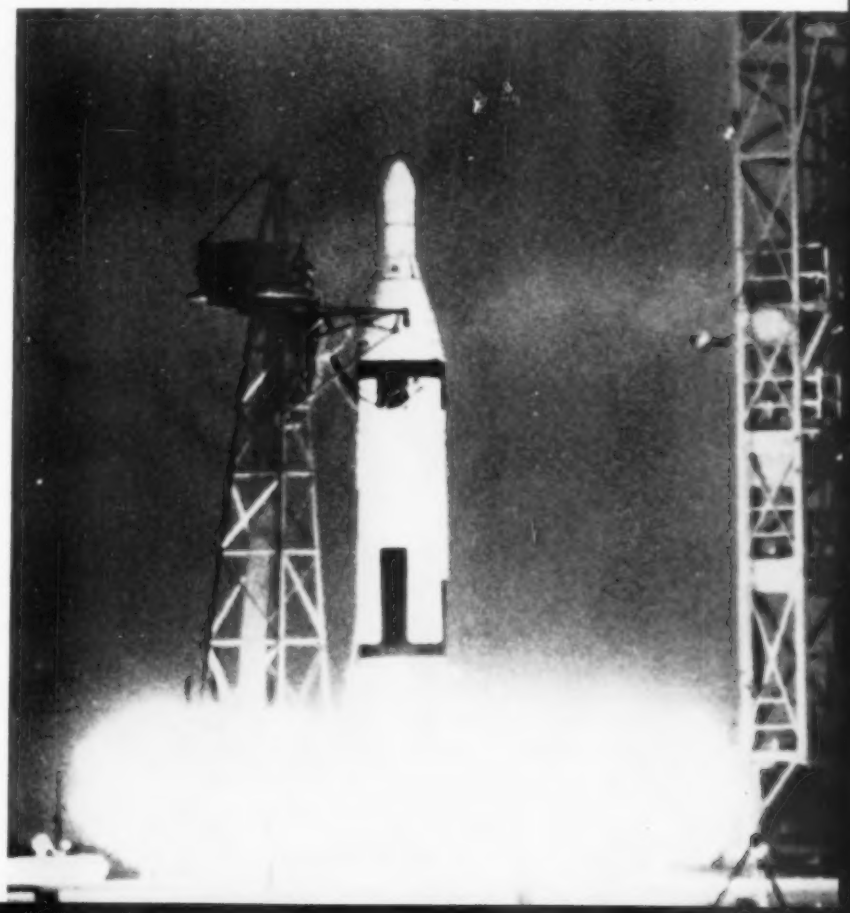
Polaris, like its companion missiles to be launched from positions on land, is one of our so-called "deterrent" weapons. Its sole purpose is to deter a potential enemy from committing acts of nuclear aggression on us or our allies. It might be added, parenthetically, that we are pledged to come to the aid of no less than forty-five nations, should they be victim of such attack.

National policy calls for a strong deterrent force, suitably deployed. Today, such a force is our great air armada of the Strategic Air Command. Such a force, too, is represented by our Navy's carrier aircraft, particularly those of the Sixth and Seventh Fleets.

But no one can draw a sharp line between what is and what is not a deterrent weapon. Certainly the Marines and soldiers landed on the beaches of Lebanon served as deterrents to the spread of trouble. Certainly, too, the powerful Seventh Fleet in the Formosa Straits and the jet fighters poised on Taiwan are deterrents to rash adventures by the Chinese Communist leadership.

We are faced with powerful forces under a leadership that has plainly announced that its ultimate goal is world domination. We have seen that leadership seek such domination in many ways. It has probed our willingness to shoot, as in Korea. It has probed

Recent firing of the Polaris tested first- and second-stage separation, flight control reaction, and performance of solid propellant motors (Navy photo).



our willingness to take grave risks by military action, as in Lebanon and at Quemoy. It has sought to bleed us white economically by forcing us to keep huge armed forces in being and to support the economy of weaker peoples. It is competing with us for world markets, for world opinion, and for industrial and technical leadership. We all remember too clearly the impact of the "Sputniks".

And now we are faced with the menace of a submarine fleet nearly ten times larger than that with which Hitler took his great gamble on the validity of the pledges of Britain and France to come to the defense of Poland.

We cannot know just what is in the minds of the leaders who have announced that world Communism is their goal nor just what they might regard as a "favorable" opportunity to take by sudden attack what they are seeking to gain by other means.

We can, however, prevent the tragic errors of judgment which caused World War I, World War II, and the Korean war. In all three cases the error was the same—the aggressor did not really believe that the other side would fight. That was the mistake made by the Kaiser's government, by Hitler, and by the Communists, as later documentation has shown.

Polaris is a factor in our national policy of standing up to the Communist leadership and making perfectly certain that we will retaliate—immediately, massively, and unpreventably—to nuclear attack. Its particular function is to pose the threat of retaliation from positions unknown as to number and unknown as to location, positions which cannot be wiped out by massive surprise attack, positions which cannot be "taken care of" in advance without giving a clear warning of intentions.

TOGETHER with all other forces—the amphibious forces, the antisubmarine forces—Polaris is a component of the new Navy.

The cost of Polaris to the American taxpayer will be substantial. It will, however, be relatively economical after the initial cost because the submarine's useful life is about fifteen years. Hopefully, then we could possibly effect some over-all savings in the national deterrent picture which could permit the application of these savings to the more conventional arms and thus keep high our capability in this important matter.

The over-all defense cost is part of the price we must pay to preserve our way of life. No one can foretell whether, with a strongly armed and alerted free world, all-out nuclear war can be averted. There are diverse opinions on this point, in political and military thinking alike.

But one thing is certain—that if the free world ever lowers its guard the other world will, in a colloquial term, most certainly "lower the boom" on us.

Never before has sea power been as vital to us as it is today. Never before would the price exacted for the loss of sea power be so swift, so comprehensive, or so staggering.

A look at the globe shows that if the free world powers can ensure the freedom of the world's oceans, we will have access to some seventy per cent of the entire surface of the earth. Were Communist hands to gain control of the oceans, overnight the situation would not only be reversed, but *they* would control nearly ninety-five per cent of the earth's surface.

The United States would then be an island, isolated from our forces overseas, from our friends and allies, and from many of the raw materials we need to maintain our national existence. We could be "picked off"—let there be no question about that—for they, too, have long-range nuclear weapons and hundreds of submarines to blanket our exposed coastlines, aside from their ballistic arsenal.

The cost of military weapons, specifically the weapons of sea power, is the highest in history. It probably will get higher. But the choice with which we are faced is a simple one. We can afford only one kind of Navy—the best and the strongest. We cannot afford any Navy which is not powerful enough to keep the sea lanes open should the final showdown come.

Our Navy must be prepared for fighting and winning the small conventional war. In this type it is supreme, and it can bring pressure to bear with great flexibility and thus prevent the so-called small war from developing into a large one.

In Polaris the practical application of sea power moves into its fourth "medium." First, of course, navies used the surface of the seas. Then came the submarine, adding the ocean depths to the Navy's area of operation. World War II and Korea saw the Navy move into the air as its long-range medium of combat, and soon sea warfare weaponry will witness the strange and even amazing partnership between two extremes.

On the one hand is the vehicle, the Navy's ship that can travel far, fast, and deep, performing its functions in the black pressures of the ocean depth. On the other hand is the weapon itself, the Navy's missile that can travel far, fast, and high, spending nearly all of its short, 15-minute lifetime in the empty vastness of outer space.

We believe that Polaris will give the Navy new significance as a factor in maintaining peace; that it will add important strength to our deterrent force in an era of transition from reliance on delivery of nuclear attack by known and proven vehicles to weapons systems measured in wholly new dimensions.

WE believe that Polaris will serve the country best if it is never launched. In fact, we believe that our mission and responsibility is to make sure that by its very existence the threat of the Polaris missile will justify the efforts and skills and dedication of the thousands of people, in the Navy, in science, and in industry, who have joined in its creation.

Finally, we believe that in the development of Polaris and its supporting mechanisms we will have unlocked doors of technical achievement that can be applied to the purposes of peace.

EDITOR'S NOTE.—This article is based on an address given before the Albuquerque (N. Mex.) Post of the American Ordnance Association.

The Arsenal Philosophy

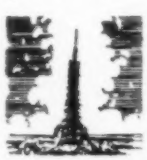
An analysis of the place of the service research and engineering centers cooperating with American industry in the struggle to develop the most modern firepower for national security and peace

Maj. Gen. J. B. Medaris

General Medaris is Commander, U. S. Army Ordnance Missile Command, Redstone Arsenal, Ala. This article is based on an address given by General Medaris before a recent meeting of the St. Louis Post, A.O.A.

In order to understand the kind of management philosophy exemplified by the Army Ordnance Missile Command, which was established in March 1958 to consolidate all of the Army's missile and space development activities under a single and integrated management, it is necessary to understand the total mission of the Ordnance Corps. That mission is to provide the munitions and fighting equipment required by the Army and to furnish service for that material wherever it may be found.

Perhaps I can emphasize the mission still further by stating it this way: It is the responsibility to provide armament to the Army and to its sister services, as distinguished from other military requirements of the Army, many of which may have at least functional counterparts in the commercial field.



Army Ordnance responsibility for its material is absolute. It begins when the item is an idea, born in the brain of a design engineer or in the mind of a combat officer anticipating a need. It extends throughout the entire process of design, research and development, fabrication and assembly, testing, specialized technical training of supporting troops, deployment and field service. It continues until that piece of equipment is finally demobilized, disposed of, or declared obsolete. It encompasses full responsibility for quality, for reliability, for maintainability, for usability, and finally for the safety of the individual soldier who employs the weapon and of those who must transport it and handle it.

There is no way by which we can or should attempt to divide or avoid that responsibility. We accept it. We expect always to discharge it competently, so that the Army is forever ready to do its part with full assurance that its equipment will meet every requirement in the acid test of combat, when it is a matter of life and death to the soldier and to the Nation.

Inescapably bound up with this solemn trust is the responsibility we assume to the American taxpayer, who is entitled to receive maximum value for every dollar entrusted to our care.

I know of no means by which anyone can discharge that kind of responsibility without having competence in all the levels of effort involved—from research and development through the entire cycle of production, maintenance, supply, distribution, care of equipment in the field, and training of personnel who will maintain and use it. All these are part of the total problem and cannot be handled without adequate and real ability in each area.

The organization of the Army's resources and the philosophy by which we manage our business are directed to fulfilling this total obligation. Only by demonstrated competence in every phase that touches upon the equality, reliability, capability, and cost of our equipment can we fulfill the trust imposed in us.

ANY method or system must begin with the understanding of the need. What does the Army require to accomplish its missions—to discharge its responsibilities to the Nation? Obviously, we begin by recognizing that our plans must be focused on future conditions—those conditions that might be encountered in warfare after a newly conceived item becomes available for use.

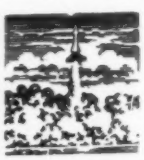
In weapons development we cannot deal in terms of the warfare of today, because it is physically impossible to change armament overnight. Therefore, we must reckon with the best information available from the combat forces, derived from the application of their experienced judgment, to evaluate the nature of the battlefield requirement as it will be by the time we can perfect something to meet it.

To that end we maintain constant communication with every authority that may be able to predict the future nature of warfare. At the same time we must be able to predict technological advances and to accelerate technological progress and all related actions involved in the development, production, and fielding of new weapons systems.

Consider the price of mistaken judgment in any one of those elements. If we err by underestimating the speed of technological advance, then the equipment in which we have invested the taxpayers' money will become obsolete by the time it reaches the battlefield, simply because progress moved faster than we had anticipated. The "X" quantities in this situation are the parallel achievements in weaponry by a potential enemy. The grim fact is that we do not enjoy a monopoly on invention or in the industrial capacity to translate scientific and technical progress into means of destruction.

ON the other hand, if we overestimate the rate of progress we may attempt something which is completely beyond the most accelerated state of the art during the period in question. Inevitably, under those circumstances the cost of the project will be much higher than anticipated, its completion will be delayed, and it may even have to be written off if it becomes impossible to reach the objective.

In no other area of human activity is the price of knowledge so high, whether you measure it in terms of the resources which must be expended or the cost to the Nation of a mistake which jeopardizes its security. Yet it is essential to our means of management that we must know with certainty and be able to predict with assurance the rate and direction of scientific and technological advance.



We must also be able to accelerate the momentum of this advance when necessary to fill critical gaps in our armament. We must be able to state and control the technical requirements that will satisfy the military characteristics needed by the tactician. Thus we can bring together his forecast and our estimate of technological progress to the same point in time, avoiding excessive specifications and requirements which cannot be satisfied.

To those who say it is impossible to schedule invention, I reply that we must do just that. If we did not, our fighting men would be denied the kind of weapons which mean life and death to them and to the country.

As the next step in our management method, we must be able to measure the performance of the products emerging from research and development. This is essential to avoid the production and deployment of weapons which cannot perform safely under conditions of stress and strain. Whatever is not effective against the enemy does not belong in the Army's inventory.

The measurements of performance must be objective and complete, so that we neither delude ourselves nor anyone else. Once committed, we must thereafter control quality in terms of performance, cost, and reliability.

Having tested the performance of a developmental item, to prove that it is right and can be entrusted to the soldier, we must know that all succeeding items are of equal quality and that there is no deterioration of the characteristics initially designed and built into the item.

The over-all cost must be related to the military value. We do not always know what that cost should be, but by long experience in the scrutiny of basic costs and in turning out military products we can make a pretty good analysis of whether we are getting our money's worth.

Finally, we must know that the equipment is maintainable, and we must be prepared to maintain it. We must see that it is equally as efficient in the field as it was on the proving ground and that it remains so. If one hundred items are consigned to the combat arms, and if the defense of the country depends upon those items, we must guarantee that at least ninety-nine of them are ready to operate at any time. The achievement of this state of readiness goes back to the drawing board and to every step in the process from design to deployment.

We must stand behind the reliability of our material and evaluate it in terms of the combat environment. We must be prepared to face the tactical commanders, the men responsible for success in battle, and say to them: "We know you can rely upon this equipment—it will not let you down. You can use your own intelligence and leadership with full reliance upon the performance of your armament in combat."

Reliability is a function of the Army's decisions at every step along the way, from the birth of the concept to the finished product. Men experienced in this unique business can look objectively at the development, almost before it begins, and tell us what degree of reliability problem will be encountered, and, depending upon the type of initial design, to what extent those problems will exist.

Reliability is a function of all the actions that take place through an entire program—through design and tests of successive stages of design, through corrections made during design, through testing and production and the assurance of continuous quality production, and finally through supply and the protection of quality in the distribution system.

The Army's credo of management begins here. We believe that all these important decisions must be made by men who have to stand behind them and be counted—by men who must face the combat officer and the soldiers who carry their lives in their hands on the battlefield. We can't have those decisions made for us by other people over whom we have a lesser degree of control.

SUCH decisions must be made on the basis of our own knowledge, reinforced by the knowledge of others in an equally objective position. We must be truly able to control our business. We must have technically competent people within the framework of Government who have no conflicting interests and cannot afford to be other than objective.

If we are to maintain the perspective

necessary to direct the activities of those segments of industry that carry the production burden for us, we must, of necessity, have sustained technical competence. I would remind you there are no commercial buyers for these products—these are not lawnmowers or washing machines. These are items for which there is neither a technical nor a commercial market because they exist solely for the business of war. They mean the life or death of an enemy or of the man who employs them. This is our center of focus.

THE foundation of our management system rests upon two postulates. The first is that the application of control requires the capability to control, not just by influence or suggestion, but by direction when necessary. Otherwise responsibility becomes an empty word and is assumed on the basis of open trust rather than upon a firm foundation of knowledge, with the assurance which knowledge alone provides.

The second postulate is that control requires experience as well as knowledge. Without experience we must rely upon faith which may have no valid basis. You cannot know whether faith is well-placed unless you have experience and knowledge.

Engineering knowledge deteriorates in a vacuum. Any competent scientist or engineer will agree that if he is denied the responsibility for actual work, or the opportunity to do and see or to say how to do, and thus test his own judgment, he will deteriorate. Eventually he will become the type of engineer who looks at someone's blueprints and hopes he is right but who is always haunted by a nagging doubt because his experience is not current.

Confidence is related to experience, and assurance is the vital factor in this assumption of responsibility. To be sufficiently confident to tell others that a course of action is not right—that they must do it another way—one must know how it should be done and be sure he knows.

This capability is essential to the Government's interest on behalf of the soldier and the taxpayer. The Army must be assured that the men to whom it entrusts responsibility cannot be defeated by lack of knowledge. We must also know that our partners in industry will respect the judgment of those men and accept their direction.

To know engineering we must perform engineering. To that end we must do a certain proportion of our business in Government installations. Part of our work must be in the hands of those upon whose judgment we must depend to control the vital factors related to the quality and value of the products made for us by others.

This does not mean that we are interested in doing that which we should not do, or that we do not appreciate and make full use of the industrial might of the United States. It simply means that we perform that amount of work which we deem necessary to the end that we may control the product for which we are responsible and have the knowledge essential to that control.

I can give you a measure of what this means in terms of percentages of our total program. We spend about one-quarter of one per cent for the operation of the Ordnance Missile Command headquarters. We spend five per cent for systems management and technical supervision, including testing and range management. We spend five per cent for research, engineering, fabrication, and technical effort to maintain the in-house capability to evaluate and direct our industrial contractors. We spend 89¾ per cent with contractor organizations—private industry, if you will. These are averages, of course.

The amount of in-house effort we devote to any given project depends upon our special abilities and needs for that particular project, or, stated inversely, the degree to which that system requires the benefit of in-house effort. These degrees of system control may be placed in three general categories.

One is typified by the Jupiter intermediate range ballistic missile program, in which we developed a complete system in-house and turned it over to a prime contractor for production after development.

The second is represented by the Nike program, which was placed completely with industry because of a prime contractor's unique capability in the development of this type of weapon system.

The third approach is being followed in the Pershing program, which is something of a compromise between the two extremes. Total system development responsibility has been retained in-house, and the guidance system is being developed within our facilities. All other hardware development is with a prime contractor. For this particular weapon, this allotment of responsibilities is the one which appears to be most profitable.

Now, unless I am prepared to subject the product of this management philosophy to intelligent judgment, this dissertation becomes merely an exercise in argument. Let me offer up a slice of the pudding for your tasting.

Since 1944 the Army has undertaken the development of sixteen major rocket and missile systems. Of this total, only three have been terminated. In each instance termination was the result of state-of-the-art progress which led to more useful systems. Seven of the thirteen remaining systems are either deployed at home and overseas, or are available for deployment—the Corporal, Nike Ajax, Nike Hercules, Honest John, Little John, Redstone, and Jupiter.

In capabilities, these systems range from a surface-to-surface weapon more adaptable to the needs of the modern Army than conventional artillery of limited range and warhead capabilities, up to the IRBM system which can place a thermonuclear warhead on target at 1,500 nautical miles. They extend to air-defense guided missiles which can destroy the fastest jet aircraft or air-breathing missiles.

IN addition to this power in being, there are in advanced development or production, and soon to be ready for deployment, missile systems which supplement these capabilities or will greatly extend them. These include the Ser-

geant, Lacrosse, Hawk, Pershing, and the fantastic Nike Zeus which must search out, identify, and destroy incoming ballistic missile warheads.

The development time for those Army missile systems already deployed or ready for deployment was estimated originally at a total of 441 months. The actual total time was 465 months, or within 5½ per cent of the estimate. Systems now in development are within 3.6 per cent of the aggregate estimated development time.

Costs have been similarly disciplined. The Nike Ajax and Hercules originally were estimated to cost $98.5 million. Their development was completed at a cost of $105.6 million, or within 7.2 per cent of the original figure, and considerably below the inflationary factor in the economy during the same period, for which no allowance had been made in original estimates. In the case of the Jupiter system we found it possible to compress the development time because of the weapon's early reliability, and came up with an over-all cost 23 per cent below the estimate.

The Jupiter nose-cone program has received particular notice since it provided a solution to the problem of reentry heating, which is also of interest in space applications. This solution was achieved by Government personnel at a cost of some $22 million, a figure which is certainly nominal when assessed against the significance of the break-through. The successful recovery, intact, of several of these nose cones established Jupiter's ability to deliver its payload without damage during reentry into the earth's atmosphere.

This system of management in terms of quality, time, and cost sometimes is referred to as the "arsenal system," with an implication that the Army covets the production responsibility for its weapons systems and would monopolize, solely to preserve its own resources, the considerable share of the defense budget provided for armament procurement.

I confess that my blood pressure begins to rise when the word "arsenal" is loosely applied in this context, because this notion is so far removed from the reality of our management philosophy that it bears not the slightest resemblance to the real situation.

The six old-line "arsenals" of the Ordnance Corps were appropriately named at the time of their establishment, because they were the only sources of supply in the young Nation for munitions essential to defense. They represent so much colorful, prideful American history that I, for one, dislike to entertain the thought of changing their designations. But they have not functioned as arsenals, in the dictionary meaning of the word, for decades.

These "arsenals" have become truly great Army technical centers, led and managed by the Army Ordnance Corps. They are unique in nature and mission. They are the repositories of a store of specialized knowledge that exists nowhere else and so are of inestimable value in the continuing struggle to keep ahead of any potential enemy in the development of modern firepower.

A glimpse of history may serve to clarify the point. In 1776 Maj. Gen. Henry Knox proposed to the Continental Congress that there should be one or two "capital laboratories erected at a distance from the seat of war in which shall be prepared large quantities of ordnance stores of every species and denomination." His commander in chief, General Washington, supported the recommendation and the Congress accepted it.

THE first of what were then and continued for many years to be manufacturing arsenals was Springfield Armory, established in 1794 to exploit local capability represented by individual gunsmiths who could repair and fabricate muskets. Springfield was far enough inland from the Massachusetts coast to be considered safe from possible capture. It was close to the using troops, and ample water power was available.

"To know engineering we must perform engineering. To that end we must do a certain proportion of our business in Government installations. Part of our work must be in the hands of those upon whose judgment we must depend to control the vital factors related to the quality and value of the products made for us by others."

Another arsenal was established at Watertown, N. Y., in 1800 to produce small-arms cartridges, buckshot, and grapeshot. A third was provided at Watervliet in 1812 because the site was reasonably near the frontiers of New York State in a period when invasion had to be expected from any quarter and when hostile Indians were just across the line.

In 1815 Frankford Arsenal was established in Philadelphia to supply small-arms ammunition, artillery-ammunition components, and fire-control instruments. When the Civil War demonstrated the need of a western arsenal, Congress established one at Rock Island, Ill., in 1862.

In 1879 Picatinny Arsenal was established in northern New Jersey to store and later to manufacture powder so the Army could appraise the price it was being charged by private powder makers.

The mission of these "arsenals," or engineering centers of today, is to conduct research, development, engineering, and some pilot manufacture, to pioneer the use of new materials and methods for most effective fabrication into ordnance, to improve and adapt for mass production the design and fabrication of specialized ordnance items, to plan for industrial production, and to consult with and assist industry in planning for production for war.

At these and similar centers maintained by the Corps of Engineers, the Signal Corps, and other technical services, it is possible for the Army to acquire, retain, and develop, in a unique environment, a group of men whose thoughts and energies are directed exclusively to the integration of past, present, and future knowledge into the present and future needs of the combat Army. Through the steady and thoughtful improvement of physical resources and facilities with which they

can work, we provide another prerequisite—the opportunity for them to pursue, actively and immediately, avenues of exploration opened to them by their trained imaginations.

Through the devoted and single-minded efforts of these men we can be assured that the advancement of weaponry is specifically the responsibility of a capable organization.

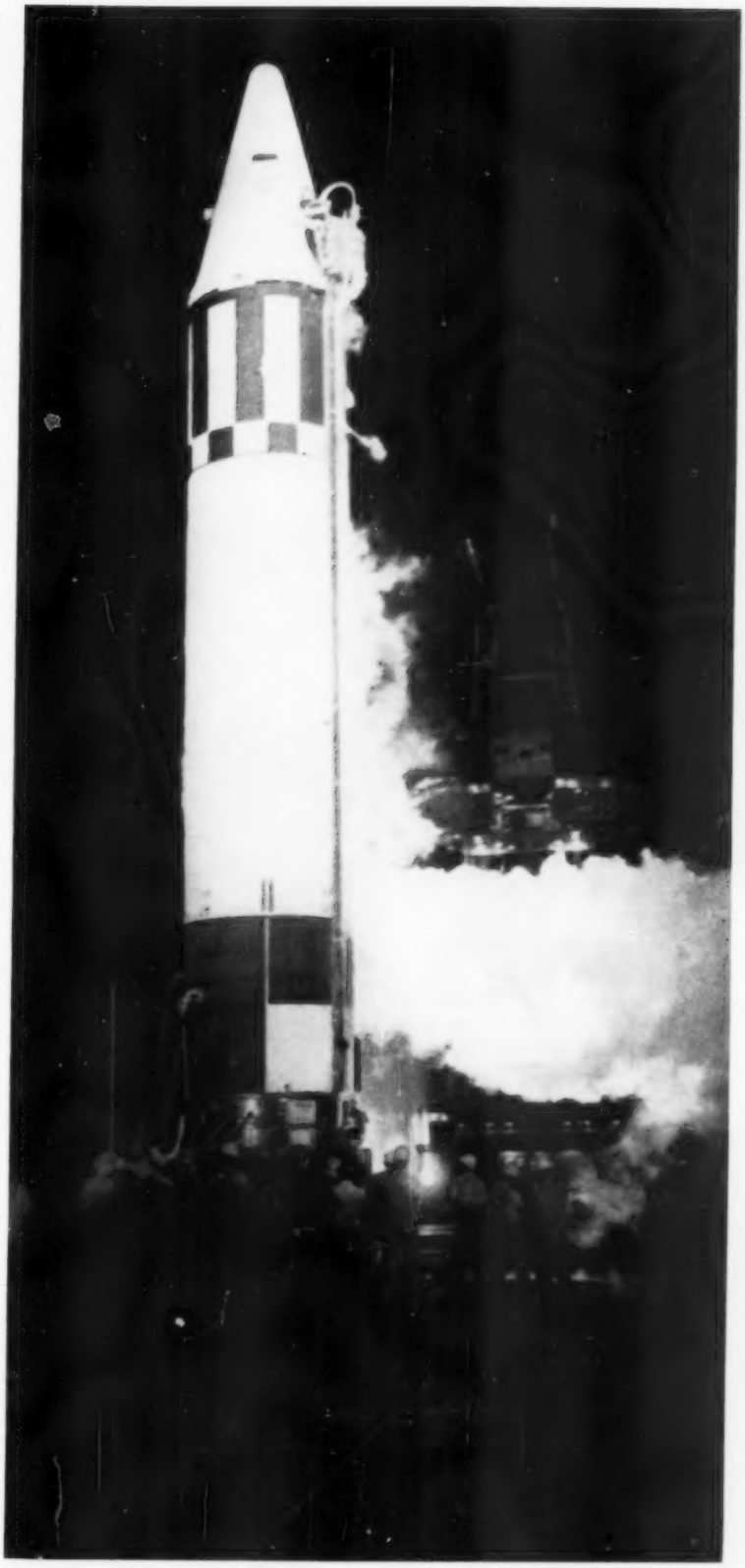
We depend in full measure on the demonstrated and expanding capabilities of American industry to do the great bulk of our work. We realize, however, that industry does not have, nor should it be expected to have, that absolute single-mindedness of purpose in the field of weaponry which must be the over-all guiding factor in our approach to our total responsibilities.

Industry has an economic function to perform, and in the American free-enterprise system the managers of industry must give heed to their responsibilities to the owners—the taxpaying public. Full recognition of that fact, without criticism, is basic to our approach in accomplishing our national-defense mission.

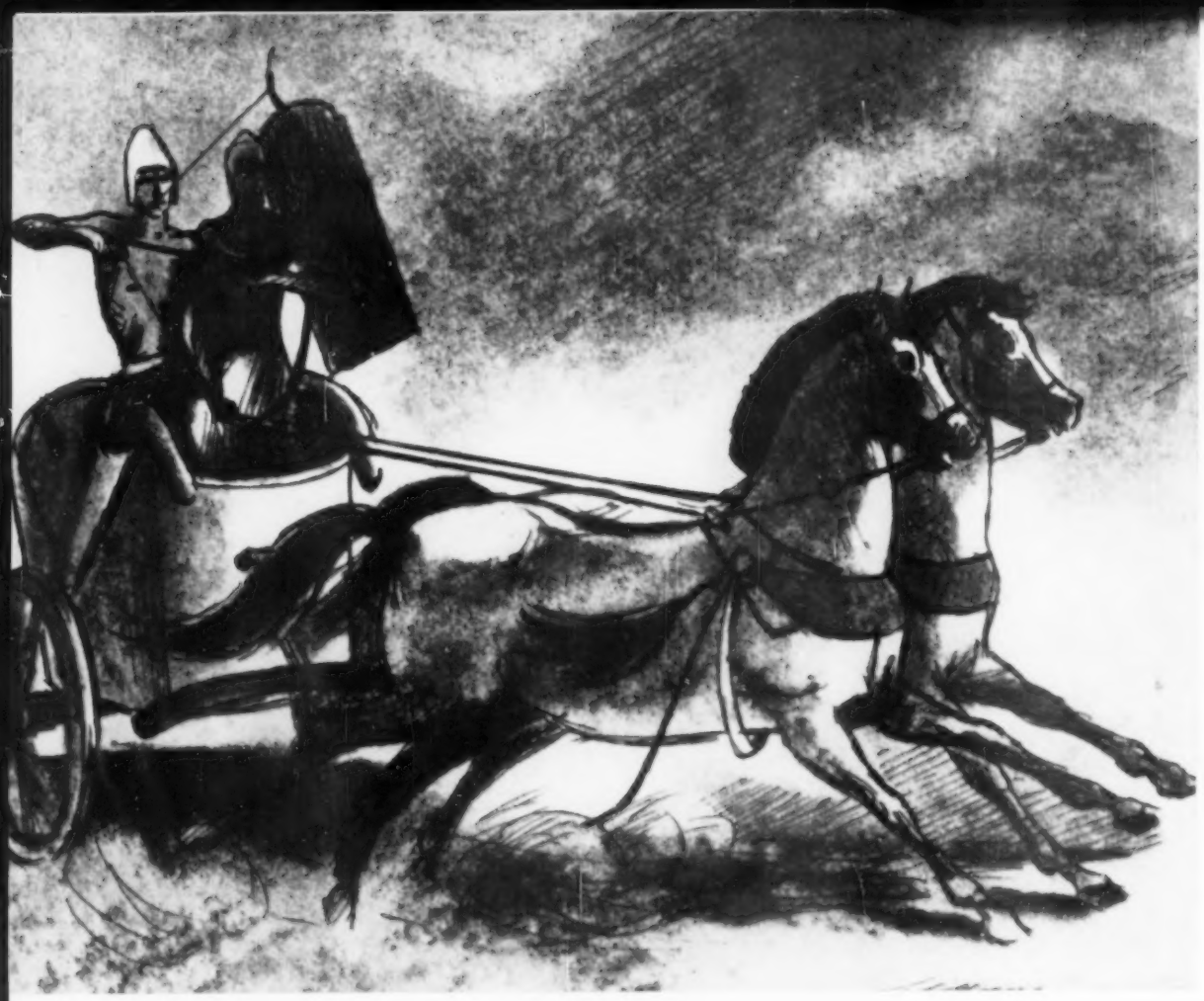
The resulting relationship has been a very fine one. I believe the vast majority of those who have dealt with the Army Ordnance Corps over a period of years have acquired an understanding of and respect for our methods in discharging our obligations.

Any substantial departure from the basic philosophy that I have outlined would necessarily imply a certain degradation of our capability, with an attendant real division of responsibility. We must and do stand up and answer for our results, and therefore we must and do control those factors essential to the achievement of results.

Within the framework of this concept, the long-developed teamwork between the Army Ordnance Corps, the national scientific community, and the great and broad front of American industry is and will continue to be a powerful force in assuring the future safety of our Nation.



An Army Jupiter IRBM stands on its launching pad just before firing at Cape Canaveral (Army photo).



Study in Generalship

A review of General Fuller's recent book on Alexander the Great

Hoffman Nickerson

MAJ. Gen. J. F. C. Fuller, the greatest living analyst of war, is well known to readers of ORDNANCE. More than any other man of our time he deserves to be called the twentieth-century Clausewitz.

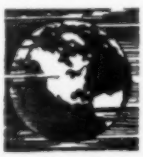
In his most recent book, "The Generalship of Alexander the Great," he deals with perhaps the most dazzling character in all history, the young half-Greek Macedonian king who in a series of whirlwind campaigns made himself "lord of Asia" and died at thirty-two the undisputed master of the world as known to the West.

The career of Alexander reads like a story out of fairyland, and, as in fairyland, here and there our knowledge of him is blurred because the accounts of those who knew him have survived only as quoted in books written centuries afterward. Nevertheless, authorities so agree about his unbroken record of success in enormously varied situations that we have a sufficient foundation on which to base our conclusions.

Our distinguished author's obvious enthusiasm for the Macedonian is turned to the severely practical purpose of military and political instruction. He whose fertility in ideas has led certain dull people to call him "a military futurist" here shows us the permanent underlying principles which should govern strategy and policy.

As chief of staff of the newly organized British Tank Corps in 1917 he saw that Alexander's tactics had much to teach as regards modern armored warfare, and the present book expands a series of lectures on this subject which he gave as a Staff College instructor in 1923. His students must have blessed him for delivering them from hearing all over again about Stonewall Jackson or the First World War!

What originally attracted this Tank Corps officer to the modernity of Alexander may have been that in everyone of the latter's major battles, except that against the Indian Prince Porus—in which the cavalry horses would not face the Indian elephants, the Macedonian delivered the decisive stroke by penetration at the head of his heavy cavalry.



One cannot help wondering how his cavalrymen, riding without stirrups and upon unshod horses, could have fought so well and marched so far, but we may remember that the earliest British tanks were far from perfect.

That the Conqueror of Asia was a many-sided genius, loved by his men, is clear. That he was in love with danger his eight wounds testify. Only luck like that of Henry IV of France kept him, time after time, from being killed. That he often was generous to the conquered and chivalrous to women, although in part due to policy, was nevertheless to his honor.

BEYOND this, however, his character is still disputed. General Fuller rejects the stories of his drunkenness and debaucheries but does not deny his furiously passionate nature and his killings of personal friends for what seem to us trivial reasons. Perhaps, however, in his circumstances those reasons were not so trivial.

Besides his luck in battle, Alexander had the good fortune to have had a highly talented father, Philip, who gave him for a tutor the great Aristotle.

Philip, half barbarian though he was, had lived in Greece and had come to appreciate both the high Greek culture and the political weakness of the Greeks because of the constant quarrels between their independent city-states. He also must have seen the weakness of Persia and had planned to organize a Greek League to help him conquer her vast empire.

In his youth he had known Epaminondas, perhaps the greatest of Greek tacticians, and he himself must have been a gifted organizer, for he had made the Macedonian army into the strong, supple, and varied instrument of war with which his son was to win so many victories.

Besides his excellent heavy cavalry, he had the men of his heavy infantry phalanx carry their shields strapped to their left upper arms, thus leaving both hands free to manage 2-handed pikes longer than those previously carried by Greek phalangites, and he supplemented his heavily armed troops with different sorts of mounted and dismounted light units, most of them armed with missile weapons.

He also must have had efficient staff departments and supply services, catapult artillery, and a remarkable engineer corps, all of which we know only from the record of their amazing achievements.

General Fuller brings to his account of Alexander's campaigns not only much reading but also a wealth of military experience. One smiles at his conclusion that at the battle of the Granicus the reason why the Persian commanders committed the error of lining the river bank with their Persian cavalry and holding back their heavy armed Greek mercenary foot was that "throughout history the cavalry soldier has despised the infantryman, and to have placed the . . . mercenaries in the forefront of the battle would have been to surrender to them the place of honor."

Shades of the "cavalry club" which so long dominated the British Army and ended by giving it a Haig to command the British Expeditionary Force in France in World War I!

Another important point is the care taken to give the reader the best possible description of the ground—a matter in which some military historians, notably the late Sir Charles Oman, have been so sadly deficient. The author of the present book has himself seen service in what was recently British India and has benefited by the detailed terrain studies of a number of scholarly travelers in Asia.

HE has reproduced for us two valuable air photographs which vividly show the almost unbroken flatness of the Irakian plain on which the battle of Arbela was fought and the tendency of that plain to give off a haze of dust even when no battle was churning up its surface into the dense clouds which hid much of the field during the action.

Two other even more vivid air photographs are of the precipitous wooded ridge in the mountainous district of Swat northwest of Kashmir, on which the almost inaccessible fortress of Aornus probably stood. The vast snow-covered peaks rearing up in the backgrounds of those photographs remind us more emphatically than words of the difficulties of the terrain in which Alexander successfully operated.

Only as to the point where the Macedonian crossed the river Hydaspes, the modern Jhelum, to defeat Porus, does General Fuller see reason to hesitate over a geographical location. Fortunately, in this case the differences of opinion have no great military importance.

Unhappily this is by no means true

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The American edition of General Fuller's book, "The Generalship of Alexander the Great," will be published shortly by Rutgers University Press, New Brunswick, N. J. The British edition was published by Eyre & Spottiswoode, London.

with reference to Alexander's tactics in his great battles. There our author frankly tells us that a certain amount of guesswork must be used in order to compensate for the absence of ancient maps and to reconcile what are to us the incomplete or cryptic statements of the surviving ancient writers. The outlines of what was done stand out clearly, and the reconstructions in this book show us much of what probably happened, but a number of details are necessarily still vague.

This reviewer found the account of Alexander's small wars and of his policies particularly interesting. The two subjects are intertwined, for in campaigns which approach the guerrilla type the attitude of the local people is superlatively important. Mao Tse-tung said that guerrillas must live among the people as fish must live under water, and their attitude depends greatly on the policies of the invading or occupying power. The necessity for wise policy today has been seared into thinking men who have seen the fruits of military victory repeatedly thrown away by political unwisdom.

The Macedonian's lesser victories as well as his great ones again and again illustrate the inestimable value of swift movement and of imaginative variations in tactics. For instance, against elusive opponents like the Central Asian horse-archers who wore down and stung to death so many Western armies as the forest Indians did Braddock, he promptly improvised a formation by which he enveloped enough of them in a "killing ground" to break their morale.

At the same time one wonders whether in his small wars he had to face opponents as cunning and as implacably hostile as more recent guerrillas. In Illyria, now Albania, he lured barbaric warriors within striking distance of his disciplined troops by taking advantage of their childlike wonder at a ceremonial review which he staged to that end. What North American Indians, Malayan Communists, or Algerian terrorists would have been such fools?

He had the enormous advantage in that most of his small-war opponents, unlike twentieth-century guerrillas, were willing to stand up and fight. In other words they offered him targets, which guerrillas should never do.

HIS mobility proves that his own men could live as hard, or almost as hard, as any band of savages. Their own peacetime standard of living must have been low enough to have freed them from the vast supply trains which encumber civilized armies today.

By contrast, one sadly remembers the U. S. Army Medical officer in Korea who said that too many American recruits there were appalled when they had to exist without a flush toilet or a bottle of pills.

I digress to ask where, when we are next forced into war, may we find a ready-made Spartan spirit among American youth? Men accustomed to the many physical comforts of a high civilization usually find it less difficult to face danger than to endure prolonged hardship.

Returning to Alexander's policies, although he must have seen from the beginning that the vast, politically sluggish populations of the Persian Empire were ripe for conquest, at the same time he understood that in order to govern them peaceably he must conciliate as many of their natural leaders as he could.

In Egypt and Babylonia that meant the local priests, who would obey any conqueror who would ceremoniously worship their gods. Throughout most of the Empire it meant the Persian aristocrats or locally distinguished natives.

Although some of the Asiatics whom he appointed to office proved untrustworthy, in general his system worked well for a considerable time.

Had Hitler been equally conciliatory in Russia the course of World War II might have been different, and his failure there, in contrast with Alexander's successes, should be borne in mind when planning for the ugly possibility of World War III.

It should be obvious throughout the West that if, without crippling losses, we can turn back Communist attacks against ourselves and our allies, we shall then have the problem of gaining a military decision over the vast territories now subject to Communist tyrannies. Such a decision can hardly be gained unless we can win over a large part of the subjects of those tyrannies to our side.

In that connection the dazzling Macedonian's last years suggest another point. He had correctly judged that his best chance of establishing his government of Asia was with Persian and other Asiatic help. It was indeed high wisdom for him to subvert the "inner fronts" of his opponents—a favorite phrase of General Fuller's and one superlatively suitable to our circumstances today.

In World War II, more conciliation of the Ukraine, White Russia, the districts north of the Black Sea and other non-Muscovite nationalities of the U.S.S.R. would have solidified those large and valuable regions for the Germans. Indeed, many of the inhabitants clung to the invaders in spite of asinine bullying by the Nazi commissioners.

BUT toward the end did Alexander overdo his conciliation of the Persians? The question is a fair one because it suggests both the difficulties of U. S. foreign policy today and those which might arise in the unhappy event of World War III when dealing with peoples whose traditions and consequent habits of mind are so abysmally different from ours.

Without trying to answer that question here, we may conclude by con-

"Should there be an ingredient which affirms Alexander's genius, it is the startling rapidity with which he always acted: no situation caused him to pause; all difficulties were immediately stormed; though risks were immense, to him success seemed foreordained. Time was his constant ally; he capitalized every moment, never pondered on it, and thereby achieved his end before others had settled on their means."—Chapter 4, "The Generalship of Alexander the Great."

sidering General Fuller's ninth chapter on "Alexander's Statesmanship" and his epilogue on "The Value of History" in which he contrasts that statesmanship with the errors of English and American leadership in World War II.

Whether or not the Macedonian's newly won Empire would have had better fortune but for his early death or whether his dream of unifying mankind must have ended in disaster we need not ask. Suffice it that throughout his career of conquest he varied his policy to suit changing conditions just as he varied his tactics—in all cases with unvarying success.

He wooed the lukewarm Greeks of Western Asia Minor by treating them like an affectionate and generous father. When, on approaching Babylon, one of the greatest Persian nobles surrendered to him without a fight, he gambled on that Persian's fidelity by appointing him to high office although the man had been one of his chief opponents in battle only a short time before.

On the Iranian plateau where the inhabitants felt themselves akin to the Persians he continued to commission Persians but always kept military command and finance in Macedonian or Greek hands. Still further East he conciliated a number of the local chiefs on terms individually pleasing to them.

Thus he reached the Punjab with his army still intact because no large detachments had had to be left behind to guard its interminable lines of communication.

LOOK now upon that picture and on this—to misquote Hamlet. Where are we and where is all the West today? The answer is all too plain: we are still the prisoners of errors made by our leaders in World War II.

General Fuller's epilogue holds that the Western leaders might have made fewer political mistakes had they studied Alexander's policy in relation to the world of his time. That world, as our author truly says, was more like our own than any intervening since Rome. Besides the inner weakness of Persia, in Greece the city-states—the permanent Greek political units—were dissolving because the traditional moral ideas from which their patriotism had grown were being heavily attacked.

> *"If the present is to profit from the past, only from a study of former periods in which the prevailing conditions resemble those of the present are profitable lessons likely to be found . . .*
>
> *"In Chapter 1, striking resemblances are to be found between the conditions that prevailed in the fifth and fourth centuries before Christ and those in our present age. There is a dissolving civilization in which the city-states reduplicate the endless wars and discords of the national states of these days; the city-states as hidebound as the national states, and equally blind to the need to sacrifice some of their sovereignty in order to face the threat of being overwhelmed."*
> —Epilogue to "The Generalship of Alexander the Great."

"Democracy was as emotional and therefore as irrational as it is now; demagogy was as prevalent; the socialist welfare state, in which unearned dividends are distributed among its members, was as well known."

Consequently Alexander, like our leaders today, was dealing with communities which had "inner fronts" capable of being dissolved by propaganda. Obviously propaganda, however expensive, is far cheaper and therefore, in its place, often more efficient than the use of large-scale military force.

Hitler began by seeing this clearly, without the benefit of history and thanks solely to his World War I front-line service together with his observation of Communist methods. As he said in a famous passage quoted in this book: "How to achieve the moral breakdown of the enemy before the war has started—that is the problem that interests me."

He did, indeed, lose his head in Russia, but only after he was drunk with repeated military successes, like so many self-made rulers before him.

General Fuller concentrates most of his fire on Churchill. Although Americans will naturally think first of Franklin Roosevelt, our author is correct in stressing the Englishman for two reasons. First, because the pattern of the war had already been set while F. D. R., like an actor impatient for his cue, was still forced to wait in the wings; secondly, because it is difficult to convict the light-hearted squire of Hyde Park of any positive ideas whatsoever about foreign affairs except perhaps an undiscriminating dislike of all Germans.

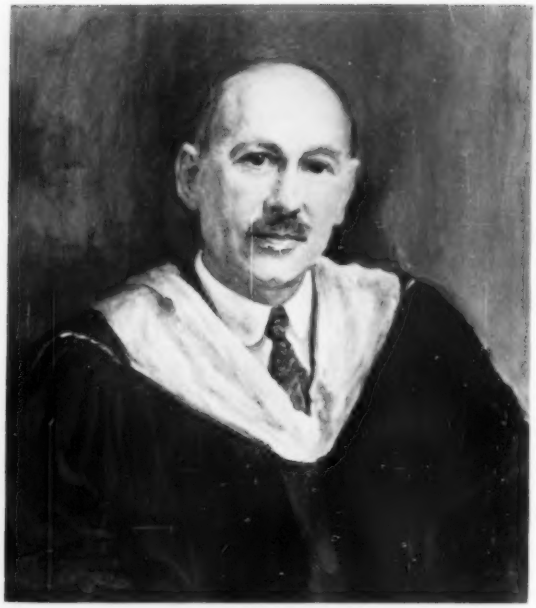
Deft though he was in domestic matters, there, too, he seems always to have been absorbed in immediate things without thinking of whither his policies were likely to lead.

England, on the other hand, began the war with a correct psychological strategy which even Churchill followed when he first became Prime Minister. His much-abused predecessor, Neville Chamberlain, had encouraged the formation of an anti-Hitler inner front in Germany by broadcasting: "We are not fighting against you, the German people, toward whom we have no bitter feeling, but against a tyrannous and foresworn regime."

AS late as that day in June 1941 when Hitler invaded the U.S.S.R., the much-praised Winston still was wise enough to broadcast that "any man . . . who fights against Nazidom will have our aid."

Then, alas for England and to the eventual benefit of no one except the Communists, he lost sight of the steadily increasing anti-Nazi German groups —to the high satisfaction of Hitler's chief of propaganda, Dr. Goebbels. On January 23, 1943, while the two chief factions of the German opposition were secretly meeting in Berlin to decide upon a common plan of action, Churchill and Roosevelt announced from Casablanca their policy of unconditional surrender.

Thus fourteen years after that surrender the Kremlin still has the power to bait us while we try to build up West Germany and Japan in order to fill the strategic vacuum our leaders created.



Dr. Robert H. Goddard
1882-1945

Portrait by Emily Burling, now in National Air Museum, Washington, D. C.

THE AMERICAN ORDNANCE ASSOCIATION

Announces with Pride the Establishment of

THE DR. ROBERT H. GODDARD TROPHY

to be Awarded Annually to

the Outstanding Cadet in Mathematics

AT THE UNITED STATES AIR FORCE ACADEMY

Colorado Springs, Colorado

The first award of the Goddard Trophy, a Winchester Model 70 rifle in the Featherweight 22-inch-barrel style, took place June 1, 1959. The recipient was Cadet Brock T. Strom, U.S.A.F.A., '59. The award ceremony was incident to the first graduation exercises of the institution.

The presentation was made on behalf of the American Ordnance Association by its past president, Gen. Benjamin W. Chidlaw, a founder of the Air Force Academy and, at the time of his retirement from active military service, Commanding General of the Air Defense Command.

Dr. Robert H. Goddard

America's pioneer of liquid-fueled rockets for space exploration

IN the spring of 1945, when United States Ordnancemen were interrogating captured German scientists who were connected with the famous V-2 rocket program, they were surprised to receive this reply: "Why do you ask us these questions? Why don't you ask your rocket pioneer, Dr. Goddard? We learned these things from him."

Who was this man whom the Germans took so seriously and with such earth-shaking results as the V-1 and V-2? Why was this man derided by the press and public as "Moony" Goddard and by-passed by the military as being too "impractical"? This man, who died in obscurity just before V-J day in 1945 at the age of 62, left behind him a legacy and a testament partly written down in 22 volumes of painstaking records of experiments and theories.

Today, Dr. Robert H. Goddard and his memory are growing in stature as America's first true space and rocket pioneer. Because of this fact, it is important that we understand the highlights of his life so that we might better appreciate the future.

As early as 1908, Dr. Goddard had started a serious study of the problem of perfecting rockets for high-altitude research above the levels of balloons. Eleven years later, in 1919, he produced his now-famous 69-page monograph entitled "A Method of Reaching Extreme Altitudes." This study was the first published report on his findings and subsequently became the basis of his later studies as well as a "bible" for his disciples.

The initial computations for this paper were made at Princeton in 1912, when Dr. Goddard was thirty years old. It was during this period he calculated that a little fuel, if used effectively, could lift a payload to great heights by rocket power.

ON March 16, 1936 (seventeen years after his first monograph), Dr. Goddard published his second and last Smithsonian Report No. 3381, entitled "Liquid Propellant Rocket Development," describing the progress he had made since the last report with the following example:

"The first flight obtained during this period was on December 30, 1930, with a rocket 11 feet long weighing 33.5 pounds. The height obtained was 200 feet and the maximum speed was about 500 miles per hour. . . .

"A beginning of the problem of automatically stabilized vertical flight was also made, and the first flight with gyroscopically controlled vanes was obtained on April 19, 1932. . . . The method of stabilization consisted in forcing vanes into the blast of the rocket by means of gas pressure, this pressure being controlled by a small gyroscope."

He concluded his last report in 1936 with these words: "The next step in the development of the liquid-propellant rocket is the reduction of weight to a minimum. Some progress along this line has already been made."

Part of the progress is exemplified in the new Vanguard earth satellite launching rocket which reduced the over-all empty structural weight to four per cent of the total weight as compared with eight per cent for its predecessor, the Viking.

All of Dr. Goddard's writings and thinking on rocketry were directed toward peaceful uses. From his days as a young, unknown physicist in Worcester in 1901 until his death, Goddard was basically interested in improved methods of exploring the upper atmosphere. After long research on the problem, he had come to the conclusion that the only practical way to reach great heights, both with instruments and ultimately with human explorers, was by rocket propulsion. Until this time, rockets had been used mainly for fireworks and for shooting life lines to distressed ships at sea.

SOME of the scientific phenomena Dr. Goddard was interested in investigating were: the density, composition, temperature, and height of the atmosphere; the nature of the aurora; cosmic and ultraviolet rays; and the earth's magnetic pull. There is a striking parallel between his "package" of experiments and those of the International Geophysical Year.

Among Goddard's more significant pioneering investigations, which were firsts in the embryonic field of rocketry, are the following:

1. He developed the basic idea for the "bazooka" in 1918, although it was not used operationally until World War II.

2. He developed a rocket motor using liquid fuels, flown by him in 1918 and preceding the German V-2 by nearly eighteen years.

3. He was the first to shoot a rocket faster than the speed of sound.

4. He perfected a gyroscopic steering mechanism for rockets ten years before the Germans developed theirs.

5. He was the first to use vanes in the blast of a rocket for steering purposes.

6. He patented the idea of step rockets, which is the basis of our earth satellite launching vehicle and many military missiles.

7. He developed a mathematical theory of rocket propulsion and rocket flight on which most present-day military and experimental calculations are based, using the important "optimum velocity" theory.

8. He first proved, by actual test, that a rocket will work in a vacuum.

9. He invented the first smokeless-powder rocket.

10. He invented the first recoverable parachuted rocket instrument container by using the gyroscope to eject it.

That this humble genius made so many scientific advances that were not widely recognized during his lifetime is but another example of how the truly great minds of the world are not fully appreciated until they have passed from the scene. In Goddard's case, encomiums to his many basic contributions as the true father of the science of rocketry are only now being justly paid to him.

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Flight into Space

The most impelling reasons for our interest in space travel are the natural challenge of man to explore the unknown, the chance of new technological discoveries, and increased military potential

James W. Useller

SPACE and space flight have become two of the foremost topics in the minds of everyone. Seldom has a new era in our civilization been ushered in with such a prominent and spectacular beginning as the launching of the first man-made satellite during October 1957. With this event, space flight was transformed from a subject of general disinterest to one of everyday conversation.

To understand the challenge that is presented with the arrival of the space age, it is necessary to examine several basic questions: Why do we want to travel in space? What effect will space flight have on this and future generations? How will space flight be accomplished? Finally, it would be worth while to gain some impression of the size of the task and of our current status.

Why do we want to travel in space? There are three impelling reasons. The first of these is the natural challenge to man of exploring the unknown. The second reason is the technological advancement that the medium of space flight offers to science. The third reason is the military potential of space flight.

WE are now forming the tools that will enable us to make our first ventures into space. As in the past, the lure of the unknown holds a challenge that man must accept. This desire to conquer the unknown is the same spirit that prompted Columbus to sail westward from Europe and Magellan to sail around the world.

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As these famous explorers had the desire to venture into the unknown parts of the earth and make new discoveries across the uncharted areas of our globe, so does the space pioneer have the same desire to venture into the unknowns of space and explore the vast reaches of our universe. It is this burning desire of man to venture into the unknown that will be the important driving force behind our future space exploits.

However, something more than a desire for adventure is needed before we are willing to launch ourselves into space. We need a justification in the form of some material gain. The explorations of Columbus held promise of easy access to the gold, spices, and riches of the East. Similarly, the explorations of the space pioneer hold promise for us of vast untapped treasures of scientific knowledge.

Closely allied to the space pioneer is the scientist who is looking forward to unlimited advances through the medium of space travel. At no time in history has the scientist been so enthused as he is today with the prospect of probing the outer recesses of the universe. This reference to scientists includes scientists in practically every field from astronomy to zoology. To these men space flight opens a new door which permits them to extend their search in the unending quest for knowledge of the universe, of its planets, and of life itself.

The benefits to our future way of living and the society of future civilizations that are potentially possible through scientific advances stagger the imagination. Now that man has the capability of taking his machines and himself off the surface of the earth and into space, there is no reason to suppose that he will not be able to transform any planet, or any other astral body upon which he lands, in the same way, and perhaps even in a more profound way, than he has transformed the surface of the earth.

SPACE exploration is basic or fundamental research, and being realistic, it must be admitted that there may not be an immediate pay-off in tangible profits. In fact, there usually isn't an immediate perceptible gain. On the other hand, the magnitude of the eventual return is incalculable. The extent to which man has mastery over matter and the extent to which he can control his environment or capture natural forces for his own use, to this extent he is indebted to basic research.

The military aspects of space flight

are also nebulous, but it is certain that a strong position in the world of the future requires the ability to operate in space. Satellites, for example, will be important as observation posts of both surface activity and weather developments. Recently, the potential of the satellite in worldwide communication has been demonstrated, and there are other applications of these "man-made moons" that will have a strong impact on future military planning.

The exact role of space in military planning is not very well defined. The situation is somewhat analogous to that held by the airplane during the early years of the First World War. It may be recalled that, at the beginning of World War I, the airplane was used solely for reconnaissance purposes. Similarly, we now think of space satellites as reconnaissance vehicles. However, with the passing years, the airplane has developed to the point where it is now one of the major weapons in our military arsenal.

The development of the space vehicle is not yet defined. Some people have expressed the feeling that the nation that controls space will control the earth. Thus, if space vehicles are to be used ultimately for military purposes, we must prepare to defend ourselves in space.

CONSIDERING the second of the original questions, "What effect will space flight have on this and on future generations?" it is well to note that as we begin our experiments in space we will be collecting vast amounts of data in nearly every scientific field. Many of the observations may seem pointless and appear to have no obvious useful purpose. However, to appreciate why these observations are being made, one must likewise appreciate the viewpoint of the scientist.

It is peculiar with scientific researchers that they become absorbed with the intricate details of their work to an extent that they appear to lose sight of practicality and tend to deal with abstractions. In a basic science, it is difficult for a scientist to ascertain always the application or ultimate practicability of his efforts.

His position is illustrated by a story told about the English physicist, Michael Faraday. Faraday's pioneering work in electromagnetism had a profound effect on our later understanding of electrodynamics, leading to useful electric power.

It has been told that about a hundred years ago, when Faraday was questioned in the British Parliament about the value of his experiments, he replied, "I can't tell you what it will be good for, but I'll tell you this: one of these days you will be taxing it."

Thus, although we cannot always see the link between our scientific experiments or discoveries and their ultimate application, rest assured that ultimately they will be developed into practical benefits for society.

There are immediate gains from space research that are obvious even today. For example, there are in store such things as observation of the weather throughout the world by means of satellites; improvement in communications, particularly intercontinental television transmission; advancement in modes of transportation; and the ability to map the world and its neighboring planets to determine their shape, size, weight, and dimensions more accurately.

It is possible that the weather not only may be observed but, at some future date, also controlled. After continuous worldwide weather observation over a prolonged period of time, it is within the realm of possibility that man will come to understand the source of the weather conditions. With this basic understanding, it becomes entirely possible that he will be able to exert forces to change the prevailing weather conditions.

It appears feasible, and in fact economical, to use satellites as reflectors to improve long-distance television transmission. For example, a satellite that orbits at an altitude of 22,000 miles above the surface of the earth has a period of revolution of 24 hours. Thus, as the earth rotates the satellite will appear to remain stationary above the same meridian on the earth with only some slight wandering to the north and south of the original position which could be corrected for at the receiver.

If this satellite were a hundred feet in diameter and located over the Atlantic Ocean between North America and Europe, it would serve as an effective reflector for television communications between the continents. Studies of the economics of such a satellite have been made, and it is estimated that it could be placed in orbit for about $200,000. On the other hand, it has been estimated that it would cost a million dollars to lay a coaxial cable to Europe to accomplish the same transmitting job.

These are only a few of the many attractive advances that might be accomplished by the application of our already known space technology. There are undoubtedly many other things that the future promises that are as undreamed of today as television was upon the discovery of electricity. There is no doubt that the really important developments that are possible through space exploration are the ones that we cannot yet visualize.

The most important aspect of all of the Space Age may be neither scientific nor military, but rather its impact on the breadth of thinking and the very nature of our future society. The term "society" is used here in its broadest sense. The difference between the society of today and that of the Space Age tomorrow, in perhaps 100 or 200 years, may well be analogous to the differences between the civilization of Columbus, some 450 years ago, and that which we know today.

We are living in the dawn of what promises to be the greatest age in man's civilized development. However, we must be free to develop the knowledge obtained through space exploration for peaceful and beneficial purposes and thus for the use of all mankind. Therefore, it is imperative that the free society of Western civilization lead the way in exploring space and exert the major influence in the continual development and evolution of our civilization as we progress into the Space Age.

With this perspective for our ven-

tures into space, it is feasible to consider the third question, "How will space flight be accomplished?" The program as we currently envision it includes three types of vehicles: satellites, unmanned probes, and manned vehicles.

All three of these vehicle types have a common propulsion system—they all depend on rockets for their thrust or propelling force. Rocket technology as we know it today has been developed principally from our military missile program. Although the United States counts among its foremost men of science Dr. Robert H. Goddard, who pioneered in rocket research during the 1930's, the first full-scale rocket vehicles were the V-2's built by the Germans during World War II. There has been an intense development of rocketry in the United States during the last four or five years and in Russia for the past eleven years.

Technology that has been developed for our missiles also will be applicable to our first ventures into space. This means that we will not have to provide new technical concepts in propulsion in order to venture into space. Rather, it will be a matter of improving upon and applying our present knowledge of rocket propulsion to provide systems that will furnish the needed performance.

Of course, we will need to develop more powerful and lighter propulsion systems really to extend our space research beyond our immediate objectives, such as the moon. These more exotic propulsion systems include the nuclear rocket, the ion jet, and the photon rocket. The nuclear rocket is in its earliest stage of design, while the ion and photon rockets are little more than concepts or ideas at this time. Much research remains to be done before these propulsion systems will be available for interplanetary travel.

FOR the present, we have only the chemical rocket to propel our space vehicles. Although chemical rockets can use both liquid and solid fuels, our early applications have used only liquid propellants such as kerosene and liquid oxygen. Research is continuing to apply higher energy fuels to the chemical rockets to provide greater impulse and thus achieve greater velocities for our vehicles.

The influence of velocity on our space accomplishments is considerable. For example, a vehicle velocity of 18,000 miles an hour is required to place the vehicle in orbit about the earth at an altitude of 2,200 nautical miles. To increase this orbiting altitude to 22,000 nautical miles, a velocity of 21,000 miles an hour would be required.

Sending a vehicle to the moon can be accomplished in much the same manner as establishing an earth satellite. However, it would require sufficient energy to reach a velocity of 25,000 miles an hour. At this speed, the vehicle would be able to escape

the earth's gravitational attraction and, if the vehicle were properly oriented, it could reach the moon by coasting through the vacuum of space following the boost period.

A vehicle coasting through space in this manner would reach the moon in about five days. This type of trip would require the minimum amount of energy. The trip could be shortened to ten or twelve hours if we operated the engine longer and, of course, expended considerably more fuel. Trips to our neighboring planets would require much longer times because of the greater distances involved.

A minimum-energy trip to Venus would require 146 days. Because the planets move at different velocities, it would be necessary to wait 468 days until Venus was oriented properly for a minimum-energy return trip to earth. Thus, the round trip would take more than two years. A similar round trip to Mars, the other planet near the earth, would require nearly 2¾ years. Of course, these times could be shortened if greater specific impulse were available to the rocket.

This points out the current limitation on our space-exploration efforts, and the lack of unlimited supplies of rocket thrust for propulsion. For example, current rocket technology will permit sending a payload of 750 pounds into orbit around the moon. If the thrust produced by the rocket could be increased twelvefold, about twenty tons could be orbited around the moon. Although this is a large payload, it is only applicable to an unmanned probe-type vehicle.

If landing on the moon and returning to earth are considered, more power in the form of thrust will be required. Assuming that we have a rocket of sufficient thrust to orbit the moon with 20 tons, it has been calculated that a landing could be made on the surface of the moon, but only about one ton of payload could be returned to orbit about the earth. This is, of course, far too small a payload to consider sending a man to the moon. The point is that if the thrust of the largest rocket currently available is increased by twelve times, it still would not be sufficient to land a man on the moon and bring him back to earth. Obviously, much progress must be made in our rocket technology before even lunar landings by man are feasible.

HOW long will it be before we acquire this capability? No direct answer is possible to this question. A great deal of time lag exists between the conception of a research project and the decision to undertake it, but the lag between the decision and the accomplishment is many times greater.

Space travel will require more than discussion, decisions, and funds. It will require much technological effort and will be achieved most quickly by a systematic and orderly program of research and development.

In conclusion, two thoughts should be kept in mind. First, the advent of space flight has provided a refreshing new challenge to our civilization. Just what the Space Age holds in store for ours and future generations is impossible to imagine.

Secondly, it should be apparent to all of us that the undertakings upon which we are embarking as we venture into this promising age are indeed vast in proportion. Consequently, great amounts of time, technological effort, and money must be expended to proceed in a logical manner.

New Army Matériel

Aberdeen Proving Ground recently displayed new mobile artillery and antitank weapons, lightweight trucks, a personnel carrier armored with aluminum, and a new vehicle for recovering tanks in combat

GROUND warfare has progressed further in the last fifteen years than in the previous several centuries. This is the opinion of Maj. Gen. H. N. Toftoy, commanding general of the Army Ordnance Corps' Aberdeen Proving Ground, Md., and he proved the statement during a recent Aberdeen press demonstration of some of the Army's newest trucks, combat vehicles, and artillery weapons. Included were the T195 self-propelled 105-mm. howitzer and the T88 recovery vehicle which were shown publicly for the first time. Among the weapons and vehicles put through their paces were the following:

105-MM. SELF-PROPELLED HOWITZER T195.—This is a full-tracked, relatively lightweight (37,900 pounds versus 54,100 pounds for the M52), amphibious, aluminum-armored weapon. Power is provided by a 340-horsepower AO1-628-1 engine coupled to an XT-300-2 transmission. It has a 100-inch turret ring which permits traverse of 360 degrees (versus 60 degrees right and left traverse for the M52). The howitzer elevates from minus 10 to plus 75 degrees.

The weapon was designed to accommodate a load of 89 rounds of 105-mm. ammunition. In addition to firing the standard howitzer rounds, a newer, longer-range round is provided. The fire-control system has been simplified and laying accuracy improved.

Initially, the T195 was to mount the 110-mm. howitzer, but with the termination of the 110-mm. howitzer program it was decided to mount the 105-mm. howitzer T252, instead. Although the recoil mechanism is still the hydrospring type, it has been modified to permit quick change of tubes, and an external buffer is provided to ease the gun back into battery after firing.

SELF-PROPELLED 175-MM. GUN T235.—This weapon is a full-tracked vehicle, easily maneuverable, lighter in weight than the T162 (59,200 pounds versus 98,000 pounds), and is capable of being transported by large cargo aircraft in two sections. The weapon is designed to provide general artillery support to ground troops and close general support to armored columns.

A crew of five is required to operate and fire the weapon. The vehicle is a low, all-welded steel structure with no superstructure and with an independently operated gun and turret mounted toward the rear of the hull. A hydraulically operated spade, mounted to the rear of the vehicle, anchors the vehicle against movement by recoil of the gun. Ramming and loading are accomplished by means of a hydraulically operated combination rammer and loader, which is swung out of the way of the recoiling gun when firing.

The vehicle is equipped with five pairs of road wheels, which are also used for adjustment. The vehicle is unique in that all road wheels are provided with hydraulic lockout cylinders that can be locked from the driver's seat to provide a rigid platform for firing or they can be adjusted for good riding characteristics to meet various road conditions.

Power is provided by a 370-horsepower, AO1-628-3 engine coupled to an XTG-410 transmission. The turret may be traversed, manually or by power, 30 degrees right or left of center, and the gun can be elevated from minus 5 to plus 65 degrees.

This weapon fires a standard projectile at a muzzle velocity of 3,000 fps. It also is capable of firing the newer type rounds.

THE chassis of the T235 is interchangeable with the T236 8-inch howitzer, the 155-mm. gun T245, or the T119 and T120 wreckers.

SS-10 AND SS-11 ANTITANK GUIDED MISSILES.—The SS-10 and SS-11, manufactured by Nord Aviation of Paris, are remote-control, wire-guided missiles with a solid fuel propellant and are capable of putting out of action any tank known to exist in present-day armies. These missiles can be hand-carried, dropped by parachute, operated by one soldier, and launched from the ground, a vehicle, helicopter, or airplane.

The United States Government has contributed to the development of the SS-11 which, while based on the SS-10, is a weapon complementary to it, having greater speed, range, and effectiveness. The contribution by the United

States was made under the U. S. Mutual Weapons Development Program, a part of the American foreign military aid program.

The SS-10 antitank missile is basically designed for ground forces and is being procured for use by the U. S. Army. The SS-11, with a range more than double that of SS-10 (3,880 versus 1,600 yards), is heavier than the SS-10 (63 versus 33 pounds) and is being procured for evaluation.

The SS-10 has been adopted as a standard item of equipment for U. S. forces. A determination regarding the SS-11 will be made following the presently planned program for evaluation of this system.

MEDIUM RECOVERY VEHICLE T88.—Recovery vehicles give the troops a means for removing disabled tanks from battlefields under combat conditions. This capability permits prompt repair of vehicles which might otherwise be lost. The T88 was built by Bowen-McLaughlin-York, Inc., and is unique in being designed specifically for this mission. Previous recovery vehicles have been converted tanks, a fact which tended to compromise their utility.

The T88, soon to go into production, is heavily armored to enable the crew to carry out its mission under harrassing fire. The recovery equipment consists of a live boom capable of lifting twenty-five tons, a tow winch for extricating immobilized vehicles, and tow bars for high-speed towing when terrain conditions permit.

Defensive armament for the crew consists of a cupola-mounted caliber .50 machine gun and smoke grenades to screen recovery operations. Major components such as tracks and suspension are common to the medium-tank family with which this unit is designed to operate. This interchangeability simplifies supply of parts and maintenance in the field.

ARMORED PERSONNEL CARRIER M113.—As a result of cooperation between the Ordnance Corps and the aluminum industry it was possible to develop welded aluminum armor for use on the M113 armored personnel carrier.

The M113E2 aluminum-armored personnel carrier, above, has a low-silhouette and is capable of amphibious operation on inland lakes and streams.

Above is the T195, a new full-tracked, amphibious, aluminum-armored 105-mm. self-propelled howitzer. Below, the 8-inch howitzer T236.

The SS-11, above, and the SS-10, below, are remote-controlled, wire-guided antitank missiles made in France.

The self-propelled 175-mm. gun T235, below, is a powerful and versatile weapon. (All photos courtesy U. S. Army.)

The vehicle is designed and built by Food Machinery and Chemical Corporation to replace the M59 armored infantry vehicle. Compared with the M59, it is shorter, lower, narrower, lighter, faster, and has increased cruising range. Although smaller than the M59, the M113 can carry more troops. In addition, it is air-transportable and capable of being parachuted. A flat-track suspension is used. The vehicle has amphibious capability in protected waters such as inland lakes and streams.

The power train consists of a Chrysler 205-horsepower V-8 industrial-type liquid-cooled engine coupled through a single-speed transfer case to an Allison truck transmission which has six forward speeds and a torque converter.

Steering normally is accomplished through a controlled differential, but a set of external dry-disk brakes are available for making pivot turns. A caliber .50 heavy-barrel machine gun is carried on a ring mount at the commander's cupola.

¾-TON 6x6 UTILITY TRUCK XM408.—In keeping with demands for modern warfare, the XM408 was developed to provide a lighter ¾-ton truck for airborne operations. This is one of a contemplated family of vehicles designed by Ford Motor Company and built around the components of the basic ¼-ton M151 truck.

It is a general cargo carrier for use over all types of roads as well as cross-country terrain and under all climatic conditions. With the addition of certain special equipment, It will ford hard-bottom water crossings when completely submerged.

In the cargo version, the vehicle weighs less than half that of the standard ¾-ton M37 truck (2,870 pounds as compared with 6,000 pounds).

The vehicle is powered by a 4-cylinder, liquid-cooled engine rated at 71 horsepower, driving through a 4-speed transmission with transfer case that transmits power to the front and rear axles. All wheels are independently sprung. The front suspension consists of coil springs, while the rear tandem axles are sprung by means of articulated leaf-spring bogies.

The body and frame are of integral welded steel construction; space is provided for eight men and equipment, including driver. Seating of passengers in the cargo section is accomplished by utilizing the flanged sides of the cargo box as seat bases, as in the heavier military trucks.

¾-TON CONVERTIBLE 4x4 CARRIER XM443E1.—This is an experimental ¾-ton vehicle built by Willys Motors and is an outgrowth of the present ½-ton light weapons carrier best known as the "Mechanical Mule." This vehicle is presently being evaluated to determine the suitability of the platform-type carrier for larger payload ratings than that of the present Mechanical Mule and also to determine if the concept of the convertible platform has sufficient merit to justify further development.

The vehicle would provide a personnel or cargo carrier for use in forward areas by airborne infantry. Some of the features of this vehicle are compactness for air transport,

low silhouette, good ridability, and accessibility of the cargo space. The power plant is an aluminum, 4-cylinder, opposed, air-cooled engine which develops 100 horsepower and is installed forward of the rear axle.

Aluminum is used extensively to make the vehicle as light as possible for air transportability. It has a tubular aluminum frame, cast aluminum wheels, sealed aluminum brake drums, and wells in the flat aluminum platform for retracting the seats. The vehicle seats five passengers and, with four of the seats retracted, the platform becomes a cargo carrier capable of transporting 1,500 pounds. For protection of personnel and cargo, a cowl with windshield, top, and side and rear curtains can be installed.

Unlike the Mechanical Mule, which has no suspension, all four wheels of this vehicle are independently suspended. The parallelogram-type suspension with coil springs and shock absorbers provide excellent riding characteristics and permit high-speed operation over rough cross-country terrain.

2½-TON 6x6 CARGO TRUCK M35E7.—This vehicle is a standard 2½-ton truck incorporating an experimental engine capable of operating on most fuels available throughout the world. This is of paramount importance in modern Atomic Age operations where rapid movement and wide dispersion of units will greatly multiply the problem of supplying the combat troops with specific fuels. A further reason for development of such an engine is the greatly improved fuel economy of the Diesel type. This type is also under consideration for many other vehicles.

2½-TON 8x8 CARGO TRUCK, XM410.—The 2½-ton truck is historically the backbone of Army transport. The XM410 is a new development which, through lighter weight and of greater versatility, is better able to furnish the Army with increased mobility for atomic-age applications.

The vehicle is a part of a new intermediate truck family which also will include 4- and 6-wheel vehicles of 1- and 1½-ton capacities. The XM410 has high mobility, low silhouette, and floatability. Emphasis has been placed on using commercially available components. It is powered by a Chrysler V-8 engine driving through an automatic transmission. All wheels are independently suspended using torsion bars. A unitized type of hull is used to permit complete enclosure and protection of all power-train components except the drive shafts to the wheels. This hull also permits the vehicle to be floated in relatively smooth waters, making it independent of bridges.

Special lightweight low-pressure tires are used to lower the silhouette and improve mobility over difficult terrain. Aluminum has been extensively used to achieve the light weight needed for air transportability and floatability.

The engine, transmission, and transfer case are installed in reverse of the usual order, with the engine mounted behind the cab in such a way as to facilitate the use of future engines such as multifuel types and gas turbines. This also locates the engine in an accessible position for simplified maintenance.

The new T88 armored recovery vehicle, above, can lift 25 tons. Below is the XM408 cargo-personnel carrier.

Above, the 2.5-ton, 8-wheel-drive cargo truck XM410. Below the XM443E1 aluminum personnel carrier.

The Ordnance Scientist

The highly trained and skilled civilian professional is the backbone of Ordnance service in the Army and provides the firm base of support upon which the ground forces must depend for effectiveness in combat

Col. G. F. Powell

OVER 400 years ago, François Rabelais said that "Coin is the sinews of war." This is true. However, money will get you little unless something worth buying is available.

Today it is possible to buy a wide variety of excellent equipment for war. In the United States a great part of this equipment is conceived and designed by the scientists and engineers of the Ordnance Corps of the United States Army.

That part of the combat equipment of the Army which is not designed and developed within the laboratories and arsenals of the Ordnance Corps is, with some exceptions, designed and developed under contract with the Ordnance Corps by civilian concerns. These contractors use Ordnance Corps concepts and data, and are also, with some exceptions, guided by Ordnance scientists and engineers.

IN World War II we learned that it is foolhardy to fail to take advantage in peacetime of improvements in weapons systems which are made possible by current scientific advances. So, today, we are making every effort to stay in the lead in the development of combat equipment which will be so effective that our enemy will hesitate to require us to use it. To do this, the Ordnance Corps employs about 12,000 professional, scientific, engineering, and technical personnel.

Colonel Powell is Deputy Commander, Aberdeen Proving Ground, Md.

Let us consider the part played by the scientist and engineer in the Ordnance Corps. Perhaps the simplest statement on the subject would be that, without the engineer, the Ordnance Corps could not function. However, the same statement pertains to over 100,000 other people in the Corps. These latter include the soldiers, mechanics, storekeepers, lawyers, personnel managers, and hundreds of other categories of salaried and wage-earning men and women. Therefore I will try to spell out some of the more important matters which highlight the position of the scientists and engineers in the Corps, with emphasis on the civilian Ordnanceman.

The mission of the Ordnance Corps is that of providing and servicing ordnance matériel for the Army, and, as assigned, for the Navy and the Air Force, and of providing ordnance matériel for foreign-aid programs as prescribed.

A schematic of the organization of the Office, Chief of Ordnance is shown in Figure 1. There are three divisions—Industrial, Field Service, and Research and Development. There is also an Office of Manpower, responsible for all personnel and training matters. Practically all the Ordnance scientists and engineers work for the three Divisions.

The base for the performance of the Army Ordnance mission lies in the operation of the continental organization which is under the direct control of the Chief of Ordnance. This is a vast system of facilities and people, comprising about 2,000 Ordnance officers, 111,000 civilian employees, and 130 major subordinate elements.

THE control of the system is exercised either by the Chief of Ordnance, who reserves the direct control of certain elements to himself, or by the delegation of "operating control" (a modified form of command) of some elements to a division chief.

A recent review of the equipment situation shows that of the matériel in an American Army division the percentages indicated in the following table are ordnance matériel:

	Initial Supplies and Equipment	*Supplies Consumed in Combat*
Armored Division	91%	87%
Infantry Division	82%	85%
Airborne Division	75%	83%

These percentages give a hint of the scope and magnitude of the Ordnance Corps problem in the development and maintenance of the combat effectiveness of the Army.

Behind the Ordnance service in the Army stands the Ordnance civilian of the Ordnance Continental System, providing the firm base of support upon which the Army must ultimately depend for its combat effectiveness. The Ordnance Continental System is manned primarily with career civilian employees.

THUS we have within the system an organization with a military mission which is, to a substantial degree, operated by civilians. Hence the Ordnance Corps is dependent upon a well-integrated and functioning military-civilian team for the accomplishment of its mission.

There is a need in the Ordnance Corps to be able to rotate military personnel through successive assignments, worldwide in distribution, to meet military requirements while developing broadly experienced and competent military leaders. This requirement, together with other factors, has made it desirable to develop a stable civilian force to provide continuity and depth of knowledge within the numerous problem areas.

To meet these various requirements, the Chief of Ordnance has adopted a regular staffing policy. In the development of the staffing patterns arising from this policy, the assignment of military personnel generally has been limited to the first two levels of control, exclusive of deputies or executives. In field installations each position nominated for staffing with military personnel also calls for a civilian variously designated as "assistant," "deputy," or "executive."

Military personnel assigned as commanding officers and senior operating or senior staff officers, are of field grade. Company-grade officers and, in some instances, junior field-grade officers, may be assigned as "staff assistants" or as "project officers" on the immediate staff of the senior officers.

This latter arrangement is advantageous from a number of points of view. It obviates the necessity of injecting an officer, possibly inexperienced, into an operating echelon. It avoids embarrassment of the civilian manager or detraction from the efficiency of the operation. It also makes possible a very desirable flexibility in the training of junior officers in the problems of management and in the solution of technical problems.

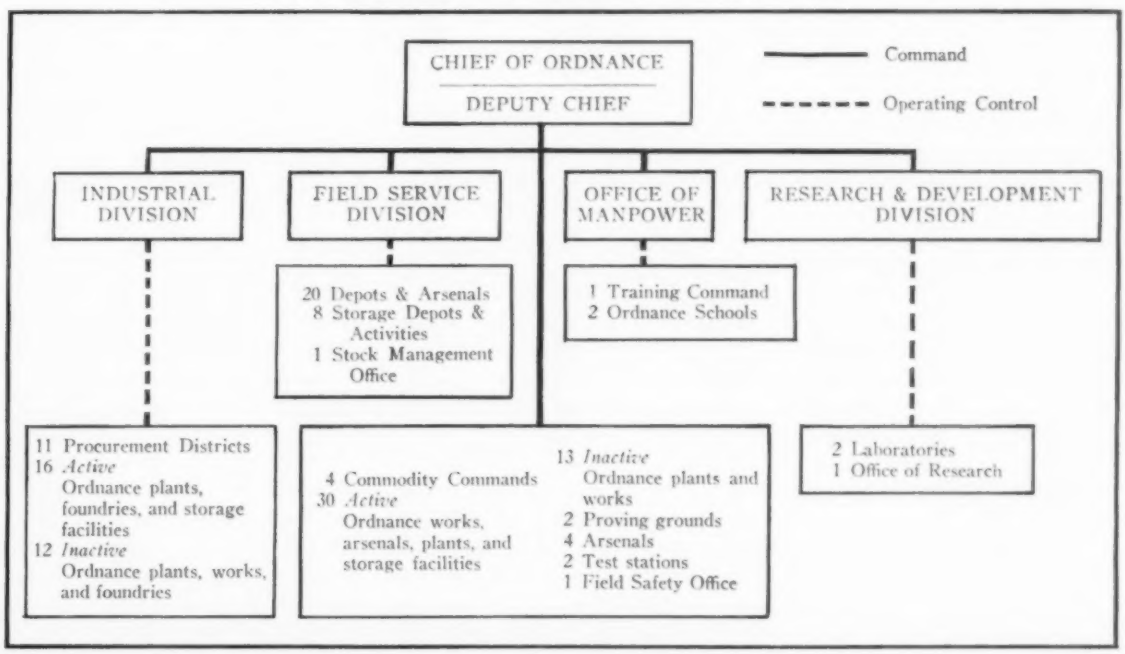
In arsenals, research and development laboratories, and industrial engineering or production activities, junior officers assigned to the staffs of senior officers often are designated as project engineers. In this capacity the officer is in a position both to contribute significantly to the operation and to develop his technical knowledge of research, development, industrial engineering, and production problems and methods.

Having accepted the idea of the complementary relationship between the military and the civilian in the system, and the contribution which each can make to the achievement of a successful operation, it has been possible to develop additional ideas designed to take maximum advantage of this relationship.

THE Ordnance Civilian Career Program is one of the steps taken by the Ordnance Corps to foster among civilian employees the full potential of management and technical leadership and to enhance the prestige of a civilian career in Ordnance. The form of the civilian career programs has been influenced by two requirements of the military. These are:

1. The provision of the military leadership and control which is of prime importance in a military system.
2. The training of junior officers for

Figure 1. Organization chart of the Office, Chief of Army Ordnance.



future positions of responsibility within the Ordnance system.

The result of the manner in which the Ordnance Continental System is organized and staffed is a structure with a solid base of civilian competence which provides technical and managerial continuity.

The Ordnance Corps is now one of the largest employers of professional and scientific personnel in the world. It also appears that the increased demand for new and improved items of matériel will continue to require considerable expansion of the professional and scientific work force.

In recognition of the importance of the civilian ordnance engineer and scientist to the success of the Ordnance cause, the Ordnance Corps conducts an integrated career program designed to maintain a vital and dynamic scientific and engineering group. The program comprises four important elements. These include recruitment and selection, intern training, advanced training and development, and the maintenance of a central qualifications inventory and referral (CQI&R) system.

The Coordinated Recruitment and Selection Program is designed to obtain engineering and scientific graduates at colleges and universities for entrance into the program at the intern level. It also results in the selection of personnel for training and development at advanced levels.

Under this program, twelve selected Ordnance installations throughout the United States are assigned the responsibility for recruitment in specified areas to meet all Ordnance Corps needs for professional and scientific personnel. Present-day circumstances require that the recruitment program yield an annual input of 500 interns a year.

The Intern Training Program comprises twenty-six weeks of planned orientation, on-the-job training, off-the-job schooling, and rotation of assignments within the training installation among the installations participating in the program and, when necessary, in the Office, Chief of Ordnance.

The objective of the Intern Training Program is to provide the selected engineers and scientists with:

1. A background and appreciation of the place of the Ordnance Corps in the national-defense organization.

2. A picture of the organization of the Ordnance Corps, its functions, policies, and procedures.

3. An early orientation on the manner in which his field of science or engineering applies to Ordnance.

The Advanced Training and Development Program is intended to increase the technical or managerial profficiency of selected employees. In each instance, the program includes:

1. Selected developmental work assignments.

2. Formal technical training through the use of academic facilities, special technical training courses, and contractor or other governmental facilities.

3. Training in management, personnel, and supervisory development.

The Central Qualifications Inventory and Referral System (CQI&R) is designed to ensure that qualified Ordnance employees are considered first for engineering and scientific promotional opportunities which arise within the Ordnance Corps. The Central Inventory of Ordnance engineers and scientists is used by all Ordnance installations in filling vacancies in the occupations covered for positions above a specified starting grade, or pay level, before outside recruiting is done to obtain such personnel.

The aim of this program is to maintain in the Ordnance Corps a dynamic group of professional scientists and engineers, on a continental systemwide basis. In addition, the program serves to improve the personal sense of continuity and of "belonging," which is so important in the development of the morale and *esprit* of a successful organization.

In addition to the more than 6,000 professional, engineering, and scientific personnel covered by the CQI&R system, there are another 6,000 professional, engineering, and technical personnel employed under 21 additional category titles who are not yet covered by the CQI&R system.

The importance of professional, engineering, scientific, and technical personnel in the Ordnance Corps is illustrated by the following tabulation:

		% of Total	% of Salaried
Total civilian employees in the Ordnance Corps	111,000	—	—
Total salaried employees	47,400	42.6	—
Total professional, engineering, scientific, and technical	12,000	10.4	25.4

In every large organization, the numbers of personnel at each grade level, if properly arranged graphically, will plot as a cone with the lower echelons providing a broad base, and the higher echelons moving to a peak. In the Ordnance Corps, the normal civil-service grade span ranges from GS-1 to GS-15. Grades 16 and above are termed "supergrades." In civilian personnel planning the grades are generally divided into four groupings. Grades 1 through 4 are considered as a "pool"; Grades 5 through 8 are the junior group; 9 through 11, the intermediate group; and Grades 12 through 15 are the senior group.

A REVIEW of the grade distribution among the professional, engineering, and scientific personnel included in the CQI&R system of the Corps shows that 43 per cent of these people are in the senior group (Grades 12 through 15). Among the professional, engineering, and technical group not included in the CQI&R system, 9.3 per cent are in the senior group.

What do all these engineers and scientists do in the Ordnance Corps? They do all the kinds of things which are inherent in the scientific, engineering, and technical professions.

They assist in the development of policy, direct projects, and do a major part of the thinking and planning essential to the development and execution of all Ordnance technical programs. They constitute one of the most important elements in the constant running battle we are waging to ensure the security of our country.

Our Army's Newest Weapons

will be shown to A.O.A. members at

THE FORTY-FIRST ANNUAL MEETING

of the

AMERICAN ORDNANCE ASSOCIATION

at the

Army Ordnance Corps' Renowned

ABERDEEN PROVING GROUND, MD.

Thursday, October 8, 1959

Since its first annual meeting at Aberdeen—forty years ago to the month—members of the Ordnance Association have had the privilege of witnessing current tests and demonstrations of the latest research and handiwork of the Army Ordnance Corps. "Ordnance Day" at Aberdeen has thus become a national tradition.

The occasion always affords leaders of American science and industry and the military services—active, reserve, and retired—to see at first-hand the progress which is under way and the needs for further cooperative effort. Ordnance Day 1959 will feature the latest advances in the fighting equipment of our ground forces.

Individual invitations with reservation forms will be mailed to all members of the Association July 30, 1959. Attendance will be limited to members who have made advance reservations. Reservations will close October 2, 1959.

See you with the Ordnance fraternity at Aberdeen on October 8th!

Is There Life on Mars?

Temperature extremes and atmospheric composition would not be very hospitable to earthmen but this does not preclude the possibility that other forms of life are adapted to this strange environment

Maj. James R. Randolph

HALF a century ago, the late Percival Lowell was devoting his fortune and the best years of his life to the building of his observatory at Flagstaff, Ariz., and to the use of its facilities for the mapping and study of Mars. His books, "Mars," "Mars and Its Canals," and "Mars as the Abode of Life," are well-known classics in this field. His map of the "canals" has needed little change in the fifty years of its existence, and is still accepted as authoritative by all observers who can see the "canals" at all.

An engineer who looks at this map for the first time, without preconceived notions of what is or is not there, tends to see it as a transportation network on a world so nearly flat that a road or railroad would go up and over rather than around. It could be a caravan map of a desert. It could be an air lines map. It could be a highway map. What seems more likely, in view of the length of some of the "canals," is that it is a railroad map.

These "canals" were first discovered by Schiaparelli in 1877. The Europe in which he had grown up was still building canals rather than railroads, so that the name he chose for these artificial-looking markings on the neighbor world might still have suggested transportation.

Several of earth's railroads would be visible from Mars because, when they were built, the Government gave the company a broad belt of land along its location. The company sold this land to farmers, who conserved the vegetation on the land they owned while overgrazing the adjacent land which they didn't own. The difference in color, due to this difference in use, would make the railroad's location visible from space. This could also be true of a river or of a canal through arid country.

Major Randolph was formerly in the Army Ordnance Reserve. He is executive vice-president of the American Rocket Research Association, a student organization to encourage amateur interest in research on rockets and the possibility of space travel.

Lowell's vision of the "canals" as an irrigation system has never appealed to engineers familiar with irrigation and is no longer tenable in view of our present knowledge of the climate of Mars. Other things being equal, the absolute temperature produced by sunlight on a planet is inversely proportional to the square root of the planet's distance from the sun (absolute temperature is 460 degrees plus the Fahrenheit temperature).

This means that the maximum temperature on earth is 247 degrees (707 degrees absolute). The maximum on Mars is 113 degrees. The equatorial daily average on earth is 70 degrees (Weather Bureau average at Panama is 80 degrees). On Mars this theoretical average is minus 30 degrees. This is 62 degrees below the freezing point and means that permafrost is normal, even on the equator and that a daily average above freezing is possible only when the humidity is high so that clouds form at night and keep the heat absorbed during the day from radiating off into space.

Measured surface temperatures on Mars go up during the day to 50 degrees in the deserts and to 80 degrees in the blue-green areas. At sunrise and sunset the temperature is usually below freezing, and on clear nights it may go to 100 degrees below zero.

THIS modern knowledge of temperatures explains more simply than does his irrigation theory the fact observed by Lowell that the darkening of vegetation on Mars in the spring begins at the edge of the melting polar cap and moves toward the equator, instead of moving up from the equator, as on earth. What's happening is that water vapor from the melting cap is moving toward the opposite pole, increasing the humidity so that clouds form at night and keep the heat in. This permits the vegetation to thaw and stay thawed long enough to get some growing done.

The color of Martian vegetation is

what we'd expect in such a cold climate, so far from the sun. In that respect it resembles vegetation found in Siberia, in northern Canada, and on high mountains. It would be quite likely to resemble such vegetation in other respects as well.

The average temperature of earth is 40 degrees Fahrenheit; that of Mars is minus 55 degrees. This makes it seem likely that the blue-green areas, originally called "seas," are oceans, sure enough, but solidly frozen, clear to the bottom, and covered with vegetation and wind-blown soil.

The spectroscope has not detected oxygen on Mars or on any other planet except earth. In a previous article I explained why it can't ("Are Planets Habitable?" ORDNANCE, January-February 1956). It has detected only a small part of the water vapor that is known from other evidence to be there. But it has found twice as much carbon dioxide as on earth. With twice the carbon dioxide, half the sunlight, and a lower temperature, the rate of production of oxygen for unit area of vegetation would be a little less than on earth, and the amount of oxygen present in the atmosphere could easily be greater. The gravitation on Mars is 0.38 that on earth, which means that with the same amount of air per square foot the atmosphere would be 2½ times as deep, oxygen would escape more slowly, and would build up to a greater partial pressure.

ON the other hand, the air pressure at the surface would be only 0.38 that on earth and would correspond to an earth altitude of 24,000 feet. In "The Naked Mountain," Elizabeth Knowlton tells how her party climbed to that altitude and beyond, carrying their camping equipment, and doing the strenuous work involved in edging their way up a rugged mountain through dangerous weather. They did not carry oxygen, but took all summer to get used to the scarcity of it. With more time, easier terrain, more comfortable housing, and less hard work to do, man could easily adapt himself to that altitude.

If an engineer could redesign his body to adapt it to life on Mars he would give it a relatively larger lung capacity. He would lower its temperature, reducing the need for oxygen. He would provide three nostrils instead of two, and a heat and moisture exchanger between the nose and the lungs. He would build the arms and legs more lightly, and more like chicken feet, controlled by tendons from muscles closer to the source of heat.

Creatures having this modification of the human form are common in the legends of northern Europe, of Peru, and of Easter Island. The Finns call them "Fire Tails," and say they were jet-propelled. The Romans called them Kobolds, and accused them of making trouble in mines. Peruvians call them Muquis, and bring the same charge. Easter Island knew them as Aku-Akus, which suggests that they were constantly sneezing. Scandanavia calls the wild ones Hill Folk ("We daren't go a-hunting because of little men") and the tame ones Nissers.

IF a Martian could study a map of earth that showed our railroads as Lowell's map shows Mars' "canals" he could probably deduce from it a good many facts about our present state of civilization and our history. Political freedom shows in a fairly even distribution of railroads, explainable in terms of the habitability of the land. Dictatorship produces concentrations around cities and a scarcity of railroads connecting those cities. A trend toward war shows in a rail net that seems to approach a line from both sides, but does not cross it.

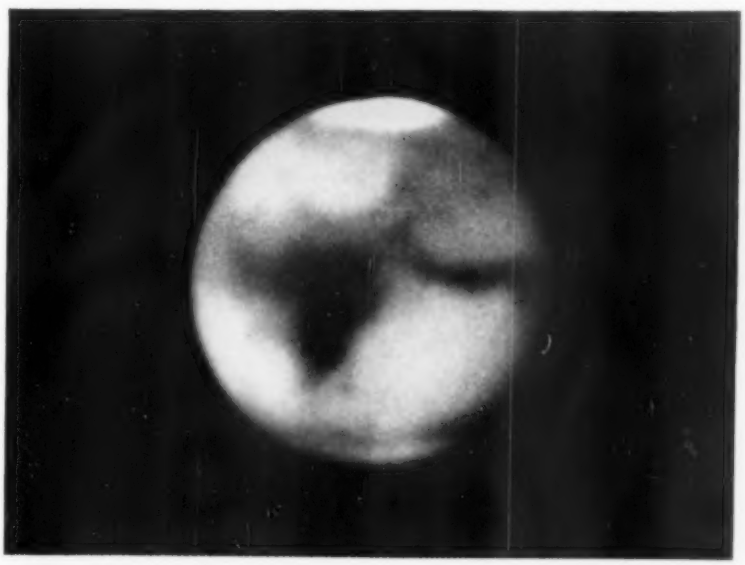
If we apply such reasoning to the map of Mars we seem to get a picture of a world that once had major political differences, but long ago became united under one government.

But we know from our own history that great countries, untroubled by war, become static, and that periods of rapid progress accompany great wars and are usually rather brief. Thus it might seem plausible that the Martians, possibly two thousand years ago, developed a civilization that made brief excursions to other worlds, and then lost interest.

Such a civilization might well have sent a colony to earth and then abandoned it. And this is just the sort of picture we can build up by a study of legends of the "little people" who look as if they might have come from Mars.

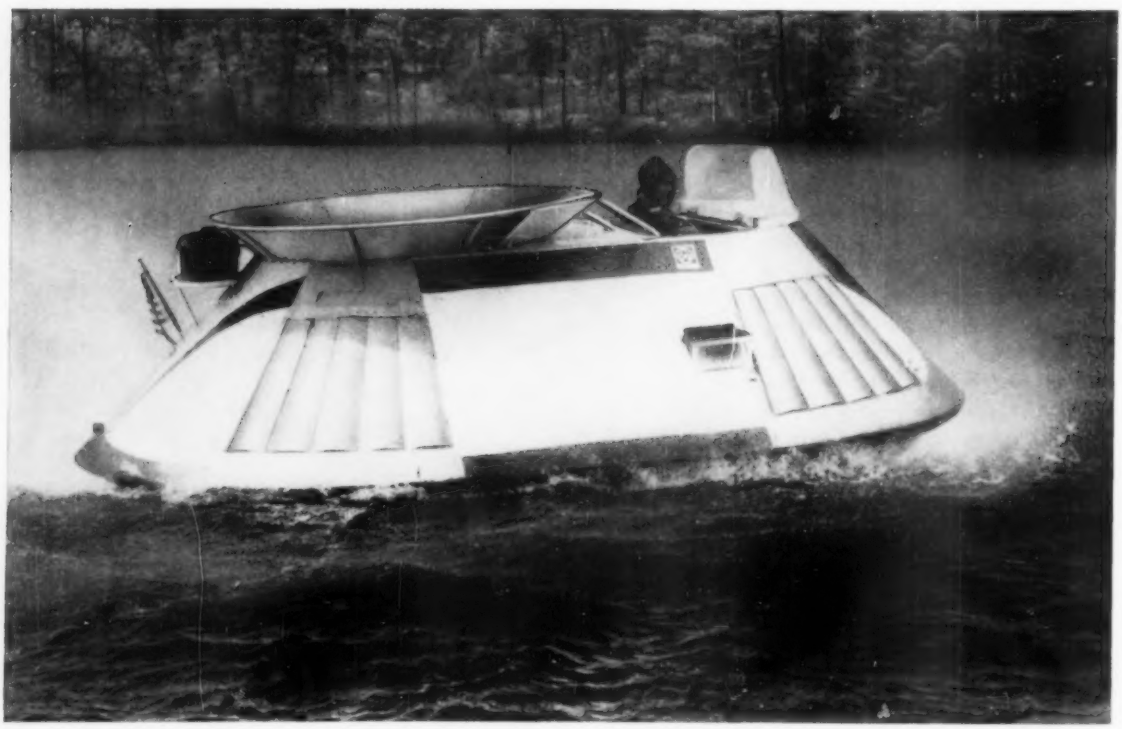
Such creatures are not as bloodcurdling as the monsters of modern science fiction. They are much more likely to be the sort of people we really might find on Mars.

Mars as it might look to approaching space vehicles (photo courtesy Dr. E. C. Slipher, Lowell Observatory, Flagstaff, Ariz.).



Riding on Air

A number of vehicles that ride on a cushion of air are now under development and may foreshadow a revolutionary breakthrough in modes of transportation. Above is the Skimmer, a test vehicle being developed by the Navy Bureau of Aeronautics, and below is the Curtiss-Wright Air Car. This type of vehicle can travel in any direction over smooth land or water surfaces.



Defense Highlights: Monthly Review and Outlook

• **Space Planning.**—Defense Department space planning was questioned in Congress because there was "no firm military space program for the next six years." A Department official politely reported that the "Advanced Research Plan" could be considered only as a forecast of possibilities. He might have added that it was too early to make firm plans since only monkeys have traveled into space thus far.

The Advanced Research Projects Agency of the Defense Department may not have firm space programs for the years ahead but it has reported an impressive array of projects started in fiscal 1959. The broad categories of work are: satellite systems (military) with 10 projects for a total of $238 million; propulsion facilities, 4 projects at $50 million; tracking and ground environment, 7 projects at $31 million; solid-propellant technology, 7 projects that take in about 40 laboratories funded at $14 million.

In addition there are 10 projects in exploratory research and 27 in the Defender Project (ballistic-missile defense) that total $5 million and $35 million respectively.

The largest projects moneywise (in millions of dollars) were the Discoverer program at 106, Sentry at 96, and Saturn at 24. For fiscal 1960, ARPA has requested a $455 million appropriation to carry on its work. All the projects are placed under a Government agency for negotiating contracts and supervision of details, with the lion's share going to the Air Research and Development Command, Army Ordnance Missile Command, and Office of Naval Research.

• **Names in Space.**—The nomenclature of earth-satellite projects, programs, vehicles, space probes, space vehicles, and launching rockets for all types of vehicles makes the confusion of missile names seem elementary.

As mentioned above, ARPA's big programs are Discoverer—a polar earth-orbiting satellite to study guidance and stability; Saturn—a launcher made up of eight clustered rockets; Sentry—a reconnaissance project; and Courier—a communications satellite experiment.

ARPA also directs Midas, an early-warning satellite program within the Defender project. The National Aeronautics and Space Administration is concerned with Mercury—a manned orbiting vehicle—and Delta, Scout, Vega, Centaur, Nova—a series of 3- and 4-stage launching rockets for satellites or outer-space probes.

Additional confusion comes into the foregoing programs and projects because they are reported at one time under ARPA and NASA—at another time under the banner of the Government agency directly involved.

Great Britain and Canada are consulting with United States authorities in preparation for launching their own satellites, further adding to the growing list of project names. It is expected that our launching rockets will be used for the initial shots.

• **Monkeys in Space.**—Two monkeys had an out-of-this-world ride in a Jupiter missile on a space-available basis. As the mice were understood to have reported in a previous launching, "It was better than having cancer." Several people complained of cruelty to the monkeys—but did not volunteer to replace them.

The medical experts derived excellent data through the telemetering channels, and the "passengers' " condition upon recovery showed no signs of excessive strain. The medical analyses indicate that the stresses of launching and recovery will not exceed man's normal endurance. Thus the principal final obstacle to putting man into space is the need for a 99.9 per cent assurance of recovery after reentry.

• **Succession in Defense.**—President Eisenhower has announced the order of succession in the Department of Defense, in case the Defense Secretary is absent or incapacitated, as follows: Deputy Secretary of Defense; the Secretaries of the Army, Navy, and Air Force, in that order; the Director of Defense Research and Engineering; the Assistant Secretaries of Defense in order of their length of service; the service Under Secretaries and Assistant Secretaries.

• **President Cleveland vs. Paternalism.**—Seventy-two years ago the United States Government was not a charitable organization! President Grover Cleveland's disapproval of an early attempt to destroy the self-reliance and independence of our citizens should bring some shame to the mass of boondogglers who now support special interests. President Cleveland told Congress in 1887:

"I return without my approval House Bill No. 10203, entitled 'An act to enable the Commissioner of Agriculture to make a special distribution of seeds in the drought-stricken counties of Texas, and making an appropriation (of $10,000) therefore.'

"It is represented that a long-continued and extensive drought has existed in certain portions of the State of Texas, resulting in a failure of crops and consequent distress and destitution.

"Though there has been some difference in statements concerning the extent of the people's needs in the localities thus affected, there seems to be no doubt that there has existed a condition calling for relief; and I am willing to believe that, notwithstanding the aid already furnished, a donation of seed grain to the farmers located in this region, to enable them to put in new crops, would serve

to avert a continuance or return of an unfortunate blight.

"And yet I feel obliged to withhold my approval of the plan, as proposed by this bill, to indulge a benevolent and charitable sentiment through the appropriation of public funds for that purpose.

"I can find no warrant for such an appropriation in the Constitution, and I do not believe that the power and duty of the general Government ought to be extended to the relief of individual suffering which is in no manner properly related to the public service or benefit. A prevalent tendency to disregard the limited mission of this power and duty should, I think, be steadfastly resisted, to the end that the lesson should be constantly enforced that though the people support the Government, the Government should not support the people.

"The friendliness and charity of our countrymen can always be relied upon to relieve their fellow citizens in misfortune. This has been repeatedly and quite lately demonstrated. Federal aid in such cases encourages the expectation of paternal care on the part of the Government and weakens the sturdiness of our national character, while it prevents the indulgence among our people of that kindly sentiment and conduct which strengthens the bonds of a common brotherhood."

• **Defense Contract Discussions.**—Renegotiation and single management of weapon systems contracts are in the legislative mill. Renegotiation advocates demanded a permanent law; opponents recommended it be dropped. The compromise seems to be a 4-year extension with a few minor changes that should aid a company that appeals the Renegotiation Board's decision, and extends the 2-year loss carry-overs to five years.

An unreconstructed economist has asked when are labor unions, farmers, miners, and veterans' organizations going to be "renegotiated" to reduce the public debt and the inflationary spiral.

A single manager for weapons systems contracting is a principal feature of Senator Leverett Saltonstall's bill to improve Defense procurement practice. Defense officials are concerned that the law might restrict their flexibility in development of weapons, the larger missile industries favor the idea, and "small business" (less than five hundred employees) is opposed.

A spokesman for Convair Division of General Dynamics Corporation points out that eighty of its subcontractors on the Air Force Atlas program started as small business but are now in a big-business status!

• **Naval Weapons Bureau.**—Vice Adm. E. W. Clexton, Chief of Naval Material, is head of the study group planning the consolidation of the Navy's Bureaus of Ordnance and Aeronautics into a Bureau of Naval Weapons. His problem is to prepare enabling legislation to present to Congress before the summer recess and to arrange the details and timetable.

The combined staff will comprise about 4,400 personnel in Washington and 200,000 in field activities. The new Weapons Bureau will control about sixty per cent of the Navy's research and development appropriations.

• **Medium Tank Production.**—In the furious spending for missiles and space vehicles it is gratifying to know that the Army was able to portion out about $20 million (approximate cost of 20 Atlas ICBM missiles) to Chrysler Corporation for production of 180 new M60 medium tanks mounting 105-mm. guns.

However, even the missile supply seems sadly limited in the Navy which has reported that the 1960 budget allows for producing only enough air-to-air Sparrow III and air-to-surface Bullpup missiles for one month of combat.

• **Underground Communications.**—Communications to missile-launching sites from control centers can be made almost invulnerable to damaging attacks. A plan to do this by use of low-frequency transmissions through the ground is under study by scientists working for the Air Force.

Tests have revealed that signals transmitted underground at a depth of several hundred feet will travel just above and below the earth's surface and can be picked up by a properly attuned underground receiving set. This technique has worked best under flat terrain but the degree of ruggedness that would stop the flow of signals has not been reported.

• **Retired Officers in Industry.**—Congress has expressed concern about the numbers of retired officers employed by firms producing defense equipment and has authorized an investigation and hearings by a subcommittee of the House Armed Services Committee to begin July 1st.

The Defense Department points out that there are several statutes that restrict retired civilian officials and regular military officers from engaging in contractual affairs with the Defense Establishment. The many retired personnel employed by industry have proved invaluable in the development and production of defense equipment because they brought with them a knowledge of the need for serviceability and simplicity. Their experience, combined with industrial manufacturing skills, has benefited both defense and industry in giving this Nation superior arms.

• **Hydrogen Bomb Blasting.**—Hydrogen bombs will blast out an artificial harbor on the northwest coast of Alaska if AEC plans are carried out. On-site crews will drive exploratory shafts this summer at a location north of Kotzebue Sound on a small creek.

Five small fusion bombs are expected to be used, one near the beach to make a channel, the others further inland to "dig out" the tundra for an enclosed harbor. By burying the bombs about 350 feet the fission products of the atomic bomb "trigger" should not exceed 5 per cent.

Since the area is only open to the sea about four months of the year the survey will not be finished until 1960 and the shots fired in 1961. As an additional benefit the operation may open up coal seams known to be in the area.

Space Exploration

An Editorial

IN a recent Armed Forces Day address, Lieut. Gen. B. A. Schriever, U.S.A.F., Commander, Air Research and Development Command, stressed what he called "our five arsenals of peace." These he cataloged as (1) the Arsenal of Positive Military Security; (2) the Arsenal of Educational Advancement for the Space Age; (3) the Arsenal of Continued Economic Growth; (4) the Arsenal of Confident Cooperation with our Allies; and (5) the Arsenal of Tough-Minded Patriotism.

These five, he said, supplement and strengthen each other. He rightfully claimed that together they provide the source and sinew of our national security.

Pages could be written on the individual importance of each of General Schriever's arsenals. In his address he developed logically and forcefully the functions and responsibilities of each. That which is in the public eye at the moment is the Arsenal of Educational Advancement for the Space Age, and it is to this that thinking men and women are today devoting so much of their time and energy.

What the future will unfold in space exploration for both peaceful and warlike pursuits defies the imagination. Quite generously our national leaders are supporting the program which, while late in its inauguration, bids fair to achieve momentous results.

A number of varying developments are under way to strengthen the Arsenal of Educational Advancement for the Space Age. The first is the crystallization of each space program under the direction of the newly established National Aeronautics and Space Administration. It is being staffed by scientists and administrators of outstanding ability.

Most wisely the Administration is assigning programs to installations of the military services which are best equipped in facilities and in talents to continue their collateral investigations. NASA is not falling into the usual pattern of duplicating costly operations. It thus demonstrates the wisdom displayed by its predecessor organization, the National Advisory Committee for Aeronautics. It is not rushing head-on into panic-inspired projects but, with a sense of moderation and yet of urgency, is undertaking a man-sized job with a prudent approach.

ONE of the NASA's happiest decisions was to name its new laboratory and headquarters in honor of America's space pioneer, Dr. Robert H. Goddard. The Goddard Laboratory will stand for all times as a symbol of the vision and perseverance of the dedicated scientist and engineer who strove against great odds to bring about not only the conquering of space but an appreciation of its importance.

With considerable pride the American Ordnance Association announces elsewhere in this issue its first award of the Goddard Trophy which will be given by the Association annually to the United States Air Force Academy at Colorado Springs for presentation to its leading graduating student in mathematics. The announcement of the first award and also a tribute to the life and work of Dr. Goddard are published on pages 58-60 of this issue.

This incident is but a minor occurrence in the progress of educational advancement for the space age. But at least it is a mark of appreciation of the importance of the new science and of a desire to promote it with vigor.

What the ultimate effects of space exploration will be on human relations in peace and war remain problematical. There are so many areas, both upon our planet and beyond it, in which vast horizons are being opened that one can only suggest an attitude of mind that should prevail about them. That attitude as we see it should be to press every opportunity for the advancement of peace—and in so doing to make certain that our ability to do so is second to none.

Hence, the conclusion is clear. In maintaining the Arsenal of Educational Advancement for the Space Age, we will be wise to use every reasonable effort to assure progress but at the same time maintain the balance both of viewpoint and of power as the means by which the peace is kept. Now more than ever it is essential that our national strength depend upon land, sea, air, and space progress with appropriate emphasis on all.

Such, it seems to us, is the greatest significance of space exploration—and this is why such exploration for the national defense of our country as well as for scientific advancement in the peaceful arts requires energetic support.

Such support of the program depends, in the final analysis, on people—and the degree of their support is in direct proportion to their patriotism. On this point, General Schriever said what every citizen will acclaim always:

"IN using the word 'patriotism' I am not referring to chauvinism, jingoism, or narrow nationalism. I am using the word patriotism in its basic sense; namely, that of love and loyalty to one's country. Today that love and loyalty demand from all of us not only an understanding of the challenges which beset us but also a heightening sense of personal involvement—that attitude of 'what can I do to pitch in and help?' It seems to me that each of us should search his own conscience and act upon the obligation that each of us has to return to our country some small portion of what it has given to us.

"This kind of patriotism should not be confined to pious platitudes or to thoughts expressed only on rare official occasions. This kind of patriotism is a 365-day-a-year variety—and 366 days in leap year. It is not noisy—only dedicated. It functions without ballyhoo in the quiet inward places of the heart."

ASSOCIATION AFFAIRS

A.O.A. Post And Division Officials Hold First Conference In Washington

The first nationwide 2-day conference for A.O.A Post and Technical Division officials began on April 15th at the Statler Hotel, Washington, D. C., with a luncheon for national Executive Committee members and officials of Technical Divisions, Sections, Posts, and Chapters.

Association President Louis Polk, president of the Sheffield Corporation and vice-president of Bendix Aviation Corporation, outlined the objectives of the conference in an introductory talk on the role of the A.O.A. in the cold war.

Col. Leo A. Codd, executive vice-president of the Association, then reviewed the achievements of the organization over a span of forty years. He also introduced members of the Headquarters staff and explained their positions in relation to the Association as a whole.

In the afternoon, immediately following the luncheon, Post and Technical Division officials held separate meetings which featured scheduled talks and open discussion.

Vice-President in charge of Posts and Chapters Henry T. Luria, Luria Engineering Company, New York, N. Y., outlined the objectives of all A.O.A. Posts and Chapters. He said they should conduct active, well-publicized meetings, encourage attendance and membership of personnel of local armed services armament organizations, and invite younger members to take an active part in Post affairs.

Capt. J. M. P. Wright, staff director for Posts and Chapters, discussed the relationship of Post members and Government activities as the military and industrial men responsible for producing superior armament. Representatives from each Post and Chapter reported on their organization's activities and future plans.

Representing their respective Posts were: Rear Adm. Willis E. Cleaves, Bendix Aviation Corporation, Baltimore, Md., president, Aberdeen Post; Col. F. R. Swoger, Aberdeen Proving Ground, Md., vice-president, Aberdeen Post; A. B. Schwarzkopf, U. S. Pipe & Foundry Co., Bessemer, Ala., president, Birmingham Post; A. B. Gregg, General Electric Company, Schenectady, N. Y., president, Capital Cities Post; G. D. Dearlove, International Harvester Company, Chicago, Ill., vice-president, Chicago Post; P. G. March, III, Cincinnati Shaper Company, president, the Cincinnati Post; George Svadeba, U. S. Naval Weapons Station, Yorktown, Va., president, Dixie Post; J. J. O'Neil, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., president, Empire Post.

Other Post officials were: T. H. Dalehite, Eglin Air Force Base, Fla., vice-president, Florida Post; W. J. Crowe, Savage Arms Company, Longmeadow, Mass., secretary, Hartford-Springfield Post; Brig. Gen. Max Volcansek, Jr., Texas Instruments, Inc., Dallas, Tex., secretary, Lone Star Post; J. S. Petersen, Day & Zimmerman, Inc., Texarkana, Tex., president, Louisiana Post; B. L. Gordon, Blackmer Pump Company, Grand Rapids, Mich., chairman, Western Michigan Chapter.

Also, Lieut. Gen. Leslie R. Groves, Remington Rand Division of Sperry Rand Corporation, New York, N. Y., president, New York Post; J. A. Dalglish, Republic Engineering Company, St. Paul, Minn., vice-president, Northwest Post; Col. R. C. Downie, Electric Products Corporation, Pittsburgh, Pa., president, Pittsburgh Post; Lysle A. Wood, Boeing Airplane Company, Seattle, Wash., president, the Puget Sound Post; Col. James Colasanti, Metal Treating & Research Company, Denver, Colo., president, Rocky Mountain Post.

Also, A. J. Mummert, McQuay-Norris Manufacturing Company, St. Louis, Mo., president, St. Louis Post; M. K. Cummings, Brown Engineering Company, Huntsville, Ala., vice-president, Tennessee Valley Post; Noah E. Hull, Hughes Tool Company, Houston, Tex., president, Texas Post; H. F. Torok, Ross Meehan Foundries, Chattanooga, Tenn., chairman, Chattanooga Chapter; William A. Seevers, Houdaille Industries, Inc., Buffalo, N. Y., chairman, Frontier Chapter; Peter Gerber, former chairman, Rutgers University Chapter, New Brunswick, N. J.

Col. Henry N. Marsh, A.O.A. vice-president in charge of Technical Divisions, presided over a meeting of the officials of the Technical Divisions and Sections. Colonel Marsh stated that the purpose of the meeting was to evaluate Division activities with the aim of making their work more effective.

Maj. Gen. Edward P. Mechling, A.O.A. staff director for technical operations, addressed the group and defined Association relations with Government agencies.

The scope and quality of technical meetings was outlined by Adm. Albert G. Noble, Vitro Corporation of America, Washington, D. C., chairman of the Underwater Ordnance Division, and by Dr. Philip H. Burdett, Remington Arms Company, Bridgeport, Conn., secretary, Small Arms and Small Arms Ammunition Division.

The technical activities of the first day ended with a reception in honor of military and civilian officials of the Defense Establishment at the Sheraton-Carlton Hotel, Washington, D. C.

Separate Post and Technical Division

A.O.A. President Louis Polk, center, addresses meeting of Post and Division officials. Other speakers were, left to right: Col. L. A. Codd, executive vice-president; Capt. J. M. P. Wright, director of Posts; Everett L. Baugh, chairman of Divisions; Col. Henry N. Marsh, vice-president for Divisions; Henry T. Luria, vice-president for Posts; R. E. Lewis, managing editor, ORDNANCE; Maj. Gen. E. P. Mechling, director of Divisions; Weber deVore, president, Philadelphia Post.

meetings resumed on the morning of April 16th. The problem of building membership within the Posts and Chapters was discussed by Robert C. Geffs, Clary Corporation, San Gabriel, Calif., and director of the Los Angeles Post. Helge Holst, Arthur D. Little Company, Cambridge, Mass., director of the Yankee Post, listed means of securing a member's active interest.

The plans of each specific Division were outlined in the meeting of the Technical Division officials. Those representing the Divisions were: Dr. V. E. Lucas, Firestone Tire & Rubber Company, Akron, Ohio, Artillery Division; Robert L. Telford, Mason & Hanger-Silas Mason Company, chairman of the Bomb, Warhead and Artillery Ammunition Division; Arthur Parquette, Ford Motor Company, Dearborn, Mich., Combat and Tactical Vehicle Division; Col. Herbert G. Messer, General Electric Company, Syracuse, N. Y., secretary of the Electronics Division; Dr. Wilmer L. Barrow, Sperry Gyroscope Company, Great Neck, N. Y., chairman of the Fire Control Instrument Division.

Additional representatives were: C. L. Eksergian, Budd Company, Detroit, Mich., chairman of the Missiles and Astronautics Division; Dr. Burdett, secretary Small Arms and Small Arms Ammunition Division; Admiral Noble, chairman of the Underwater Ordnance Division; Wilbur J. Reitze, Esso Standard Oil Company, New York, N. Y., chairman of the Materials Division; John W. Kraus, Thompson Ramo Wooldridge Inc., Cleveland, Ohio, chairman of the Packaging and Handling Division; J. M. Gruitch, ACF Industries, Incorporated, New York, N. Y., chairman of the Production Techniques Division; Dr. Alexander Flax, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., Research Division; C. Thorpe Thompson, Cleveland Instrument Company, Cleveland, Ohio, chairman of the Standards and Metrology Division.

General Mechling, in discussing the enlargement of the Technical Divisions, urged that all participants in this program be A.O.A. members. The reason for the reorganization of all technical operations was to encourage wider participation and promote even higher quality techincal meetings. The extension of the company membership program was outlined by Everett L. Baugh, Cleveland Ordnance Plant, Cleveland, Ohio, general chairman for Technical Divisions. One of the most important jobs of a Division or Section member, as stated by Mr. Baugh, is to interest management in company membership in the A.O.A. through the importance of participation in the Technical Divisions.

The last formal meeting of the 2-day conference was a joint session for Technical Division and Post officials. Mr. Polk, Association President, introduced Weber deVore, Heintz Division, Kelsey-Hayes Company, Philadelphia, Pa., president of the Philadelphia Post and deputy chairman of the Missiles and Astronautics Division, who spoke on the relationship of Divisions and Posts.

A.O.A. Headquarters support was outlined by General Mechling, Captain Wright, and Roger E. Lewis, managing editor of ORDNANCE magazine. Colonel Codd spoke on the task that confronts the members and the national-defense role of the American Ordnance Association in this age of accelerated technology.

The 2-day meeting ended at a luncheon sponsored by the A.O.A. Washington Post at the Willard Hotel. Post President Ernest A. Tupper, American Can Company, Washington, D. C., introduced the speaker, Dr. Herbert F. York, Director of Research and Engineering, Department of Defense. Dr. York listed and explained the wide scope of his program which extends from medical technology to the most complex and sophisticated missile-defense system.

Yankee Post Members Tour Exhibits, Hold Meeting At Boston Science Museum

Yankee Post members enjoyed a triple treat at their spring meeting on Wednesday, April 1st, in the Boston Museum of Science. Many members arrived at 4:00 p.m. to participate in a tour of the museum which has set up many new exhibits in the field of natural history.

Later, the members flocked into the planetarium for a most interesting demonstration. In addition to a general review of salient features of the heavens, the lecturer pointed out, at high magnification, some of the mysterious features of the moon that our space explorers of the future will help to solve. He also showed the audience how the Explorer satellite appears in orbit.

A reception was held in the exhibit hall of the museum overlooking the Cambridge River, followed by dinner in the lower meeting hall. The guest of honor and principal speaker was Maj. Gen. August Schomburg, Deputy Chief of Army Ordnance, whose fame is such that the hall was packed to its capacity of 350 and many were turned away.

Post President George Schwartz welwelcomed the members and introduced the following head-table guests: Capt. F. A. Burke, U.S.N., senior chaplain, 1st Naval District; Col. H. D. Mahon, U.S.A.F., Deputy Chief of Staff for Operations, Cambridge Air Research Center; Helge Holst, A.O.A. regional vice-president and director of the Post; Rear Adm. Carl F. Espe, commandant, First Naval District; Charles F. Adams, president, Raytheon Manufacturing Company; Brig. Gen. W. K. Ghormley, commanding the Ordnance Weapons Center, Rock Island, Ill.; Col. E. M. Serrem, commanding officer, Boston Ordnance District; and Capt. J. M. P. Wright, from A.O.A. Headquarters.

Col. John S. Pfeil, chief of the Boston Ordnance District and a director of the A.O.A., introduced General Schomburg who is well known in the Boston area from a former tour of duty at Watertown Arsenal.

General Schomburg turned the tables on Colonel Pfeil by speaking great praise of the colonel's many civic and patriotic interests and then, on behalf of Secretary of the Army Wilber M. Brucker, presented to him the Army's Patriotic Civilian Service Award to commemorate the thirteen years that Colonel Pfeil served so capably as chief of the Boston Ordnance District and as an industrial adviser to the Department of the Army.

In his address General Schomburg described recent developments that have been perfected by the Army and indicated in many cases where they had noteworthy commercial use. The general used exhibits and live demonstrations to point up the impressive results of research and development in the Army.

Maj. Gen. August Schomburg, left, presents citation from the Secretary of the Army to Col. John S. Pfeil, chief of the Boston Ordnance District.

Some of the items shown were paper clothing, solar furnace specimens, and miniature electric devices, including lamps that could go through the eye of a needle. On display was a short-pulse radar with extremly refined definition, yet

of a size that would fit in a shoe box and be usable as a missile fuze. General Schomburg also exhibited some of the recent developments by researchers in medicine, surgery, and food irradiation.

The climax was a presentation "in person" of the cat that had been subjected to seven tests with the aerosol nerve gas first revealed at the A.O.A Industrial Preparedness Meeting in New York last December. It was evident that the cat had not suffered from exposure to this chemical and the most, if not all, of its nine lives were still intact!

San Francisco Post Commemorates Founding At Spring Luncheon Meeting

The San Francisco Post celebrated its thirty-sixth anniversary with a luncheon meeting on April 16th which treated problems of missile and space progress not otherwise available to the membership. For this information the directors called on Willis M. Hawkins, assistant general manager of the Lockheed Missiles and Space Division, who spoke as an engineer, designer, and administrator on "some of the things we are doing today that influence the social and economic life of America."

Post President Jack L. Ashby, vice-president and general manager of Kaiser Steel Corporation, presided. He recounted the 40-year service of the American Ordnance Association to the national defense and the contributions made by its Technical Committees and individual members. In line with such service, he called upon Dean Witter, regional vice-president of the A.O.A., to present an A.O.A. certificate of appreciation to W. E. Waste, executive vice-president, Bechtel Corporation, for his service as 1958 Post president.

Also seated at the speakers' table were: Col. John M. Stark, commanding officer, San Francisco Ordnance District and Post secretary-treasurer; Leslie B. Worthington, president of Columbia-Geneva Division, United States Steel Corporation, Post director; Elmer R. Peterson, vice-president of Standard Oil Company of California, Post director; W. E. Butts, president of General Metals Corporation, Post director; Mr. Waste.

Also, Lieut. Gen. Charles D. Palmer, Commanding General, Sixth Army; L. Eugene Root, vice-president and general manager, Lockheed Missiles and Space Division and Post vice-president; Maj. Gen. Hugh A. Parker, U.S.A.F., Commanding General, Western Air Defense Force; Mr. Witter; Rear Adm. M. E. Arnold, Commander, Fleet Air, Alameda; Lawrence S. Fletcher, attorney, national A.O.A. Council representative; W. E. Hoard, regional manager of Western Gear Corporation, Post director; Stanley H. Hiller, Jr., president of Hiller Aircraft Corporation, Post director; and Col. H. H. Heuer, chaplain, Sixth Army, who gave the invocation.

In his address Mr. Hawkins said: "We must tell the voters and their responsive legislators what their missile money is buying. We have to keep our missile program on an even keel for more than one year at a time—we can't pay for stopping and starting. We are going to tear our pants in experimentation. But the public will understand this if we tell them what we are going to do."

Mr. Hawkins said all the background knowledge this country had gained in its tactical missiles was going into space exploration, which now primarily was in the research phase, and listed some of the following advantages in space travel:

1. The satellite is a pretty fair transport on a dollar-per-ton-mile basis, and it covers a lot of territory in a hurry. 2. In an environment without gravity, bearings can run forever. 3. Essential vacuum tubes produced on earth would work even better if you broke the glass once in space. 4. There is no interference to the sun's energy as a power source, and solar batteries work much better. 5. A small nuclear power set we must develop for space travel would provide everyone a power source he could bury in his own back yard.

"Many other problems we now fear may turn out to be in our favor, but we must have a man in space with a monkey wrench to discover them," he said.

On the present status of our weapons systems Mr. Hawkins said it was noteworthy that news of the Thor and Jupiter intermediate-range missiles was no longer on the front page as they became operational. He said the intercontinental Titan and Atlas were showing up as operational and the Minuteman, a new-generation weapon, small and hopefully cheap, was coming along by using all knowledge from the existing state of the art. He saluted the Air Force for its courage in stepping up the Minuteman development.

Discussing the Polaris, a second-series missile Lockheed is developing for the Navy, he said armchair strategists could apply these missile capabilities in devising their own war-deterrent posture for the U.S.: (1) A weapon system that can survive surprise attack; (2) one that can launch an undetected attack from any direction on the enemy; (3) be able to cover the target areas; (4) a system to pull enemy fire away from our population centers and fixed defenses; (5) once created, it does not have to be done over every few years.

"You are going to have to vote on these weapons some day," he said. "Do your own estimating on the investment cost."

As to the obsolescence problem of missiles, Mr. Hawkins said the way the nuclear submarine-Polaris system was approached "may be a pattern as important as the technical break-through.

"Admiral Raborn called a meeting and said the submarine must last fifteen years or the public would rebel. We designed the missile a long way down the road . . . and did not change the size of it, so as to use the same sub."

Any change now will be in the performance of the missile, and it is on schedule, he said. It is due for 1960 with an announced range of "over 1,200 miles."

At San Francisco Post meeting were l. to r.: Willis M. Hawkins, guest speaker; Rear Adm. M. E. Arnold, commander, Fleet Air Alameda; Lieut. Gen. C. D. Palmer, Commanding, Sixth Army; Maj. Gen. H. A. Parker, Commander, Western Air Defense Force; Post Vice-President J. L. Ashby, vice-president Kaiser Steel Corp. (Army photo).

Underwater Ordnance Division Meets At Navy Submarine Base, New London

The first session of a 3-day Underwater Ordnance Division meeting was called to order on Wednesday, April 29th, by Adm. A. G. Noble, U.S.N. (Ret.), chairman of the Division at the U. S. Naval Submarine Base, New London, Conn. Admiral Noble reviewed the requirements for the new Section memberships, stressing the greater potential of the Underwater Ordnance Division.

Capt. P. W. Garnett, commanding officer of the Submarine Base, reviewed the role of the base in the national defense. The guest speaker, Capt. J. F. Enright, Chief of Staff, Submarine Forces, Atlantic Fleet, discussed the submarine's task in the protection of the ocean lines of communication. His talk covered antisubmarine warfare as well as the latest in submarine developments.

Members of the A.O.A. Underwater Ordnance Division attended a 3-day technical conference at the U. S. Naval Submarine Base, New London, Conn.

Individual Section meetings were held in the Submarine School throughout April 29th and 30th, with the final session being called to order on April 30th. Admiral Noble asked each Section chairman to furnish a case history of the problems completed by his Section.

Chairman A. D. Anderson, Cook Electric Company, Morton Grove, Ill., reviewed the activities of the Fire Control Section. Four Fire Control Section reports have been reviewed and accepted by the Bureau of Ordnance, and four new problems will be considered.

Dr. G. R. Tatum, Vitro Laboratories, Silver Spring, Md., chairman of the Underwater Missile Section, stated that his Section has completed its reorganization in accordance with the Technical Operations Manual. Three reports from this Section have been submitted and approved, and work is continuing on the problems of standardization and design disclosure, reliability, and torpedo proofing and training. Work will be initiated on the new problem of torpedo propeller inspection procedures.

J. McWilliams Stone, DuKane Corporation, St. Charles, Ill., chairman of the Mine Section, reported that a final report on mine batteries is expected in October 1959 and that the Section report on mine-case material has been issued for comments. Specific work is being continued on mine test set calibration procedures, and a new problem on shortening the lead time for technical manuals has been accepted by the Section.

Loading Section Discusses Numerous Topics At Burlington Conference

Ammunition and explosives experts from industry and the military services gathered at a meeting of the Loading Section, Bomb, Warhead and Artillery Ammunition Division, in Burlington, Iowa, on April 7th-8th. Brig. Gen. Joel G. Holmes, plant manager, Mason & Hanger-Silas Mason Company, was chairman of the 2-day meeting.

Technical sessions were presented which dealt with methods developed by management to increase efficiency and safe-loading operations as well as means of inspection and over-all control of large loading plants. A general introduction to the conference began with "Comments on Division Activities," by R. L. Telford, Mason & Hanger-Silas Mason Company, New York City. Mr. Telford is also chairman of the Bomb, Warhead and Artillery Ammunition Division.

Particular topics were: "Reorganization Pertaining to Loading Section," by J. Stewart Petersen, Day & Zimmerman, Inc., Texarkana, Tex., deputy chairman, Loading Section; "Ordnance Ammunition Command Activities," by Col. E. Stanton Palmer, Deputy Commander, Ordnance Ammunition Command, Joliet, Ill.; "A New Look at Naval Ammunitin Depots," by Comdr. Alan Ray, Head, Missile Propulsion, Warhead, Fuze Branch, Navy Bureau of Ordnance; "Review of the Army Missile Program," by James J. Fagan, chief adviser, Office, Assistant Chief of Staff for Research and Development, Army Ordnance Missile Command, Redstone Arsenal, Ala.

Topics of a more technical nature also were given careful consideration including: "Progress on Nondestructive Bullet-pull Evaluation," O. B. Hunt, Joliet Arsenal, Joliet, Ill.; "Development of a Molded Fiber Container As a Means To Improve Packing Operations," H. M. Krengel, Ravenna Arsenal, Inc., Ravenna, Ohio; "A Survey of Plastic-Bonded Explosives Developments in U. S. Naval Laboratories," Dr. Harold J. Gryting, U. S. Naval Ordnance Test Station, China Lake, Calif.; "Adapting Existing Army-Owned Industrial Ammunition Loading Plants for the Loading, Assembly, and Packing of New Types of Ammunition," Howard L. Guenzler, Ordnance Ammunition Command, Joliet, Ill.; "Proposed Revision of Quantity-Distance Tables for Protection against Sympathetic Detonation," L. W. Saffian, Picatinny Arsenal, Dover, N. J.

Additional topics were: "Crystallization of Explosives," by Dr. Walter C. McCrone, McCrone Associates, Chicago, Ill.; "Electric Detonators," by Paul B. Tweed, Picatinny Arsenal, Dover, N. J. A social hour and dinner for the conferees ended the activities of the first day.

The agenda for April 8th included additional talks: "Cooling Rates of Multicomponent High-Explosive Systems," Dr. L. R. Rothstein, Mason & Hanger-Silas Mason Company, Iowa Ordnance Plant, Burlington, Iowa; "New Hardware Being Tested for Ammunition Packing Boxes," T. L. Gaines, Remington Rand, Division of Sperry Rand Corporation, Louisiana Ordnance Plant, Shreveport, La.; "The Navy's Engineered Time Standards Program," Omar B. Jensen, Ammunition Loading Production Engineering Center, Crane, Ind.; "Compatibility of Various Explosives with Contacting Materials," Norman E. Beach, Picatinny Arsenal, Dover, N. J.; "L/A/P Cartridge M509, 106-mm." (movie), M. H. Wegener, Mason & Hanger-Silas Mason Company, Iowa Ordnance Plant, Burlington, Iowa.

The 2-day conference ended with personally conducted tours through the Iowa Ordnance Plant of the Mason & Hanger-Silas Mason Company, Burlington, for all those attending the meeting.

Milwaukee Post's "Revival Meeting" Features Admiral Clark As Speaker

The Milwaukee Post recently concluded what was labeled the "most successful membership meeting in the postwar history of the organization." Members from all over Wisconsin and Upper Michigan arrived in Milwaukee on April 30th for a "revival meeting" which was capped by an evening banquet with Rear Adm. John E. Clark, deputy director of the Advanced Research Projects Agency, Department of Defense, as the keynote speaker.

Milwaukee Post President Algie Hendrix and Robert Uihlein, Jr., meeting general chairman, spearheaded the Post's drive to renew active participation of the area's industries in the A.O.A. and to interest individuals who subscribe to the principles of the Association.

The meeting, which included an afternoon "open forum" of the general membership and the presentation of a Post activities plan, was the first in several years.

Mr. Hendrix and the majority of board members feared that the relative apathy among the membership, if permitted to continue, might destroy the prestige and reputation of the Milwaukee Post, a longtime leader in the fostering of industrial preparedness. However the enthusiasm generated by the Post leaders was contagious and, the response to the call for a special session was far greater than anticipated.

At the afternoon meeting Col. Leo A. Codd, A.O.A. executive vice-president, praised the efforts of the Milwaukee Post and said industry must "keep in careful touch" with the defense agencies "so that we may now and in the future be able to supply these agencies with that which they need when they need it."

A "3-point plan" for future activities of the Milwaukee Post was unanimously accepted by those in attendance. The plan included an extensive membership drive, regeneration of Post spirit and interest, and changes in the executive structure of the Post. Board Member Hubert Barnes urged greater emphasis on technical committees, saying participation on them offered excellent benefits not only to the individual but also to his firm.

Admiral Clark told an enthusiastic audience at the evening portion of the meeting that America is not lacking for talent in the field of technology but that the country is "loaded with brilliant scientists and engineers."

However, he warned that an organizational problem existed. The admiral told more than 200 members and guests that he was against establishing an operation for space technology similar to the Atomic Energy Commission simply because the AEC has operated effectively.

"The fields are entirely different and necessarily require different approaches," he declared.

"The surest way to remain forever behind Russia in the field of space exploration is to be panicked into crash programs of a glamorous nature and neglect the basic work," Admiral Clark concluded.

Other honored guests at the speakers' table included: Comdr. Robert A. Mallek, inspector of naval material, Milwaukee; A. B. Goodspeed, secretary-treasurer, Milwaukee Post; Maj. Glenn Eggleston, Air Force procurement, Milwaukee; Rev. Floyd Stanton, S.J., vice-president in charge of student affairs, Marquette University; Col. Martin B. Chandler, commanding officer, 61st Artillery, Milwaukee; Sam Halpern, Post board member.

Rear Adm. John E. Clark, deputy director of ARPA, center, consults with A. B. Goodspeed, Milwaukee Post secretary-treasurer, left; J. A. Anderson, Michigan Post vice-president; Algie Hendrix, Milwaukee Post president; and Robert Uihlein, Jr., right, general meeting chairman and Milwaukee Post board member.

Also, Col. C. L. P. Medinnis, commanding officer, Chicago Ordnance District; J. A. Anderson, vice-president, Michigan Post; Maj. Gen. Fritz Breidster, commanding general, 32nd Division, Wisconsin National Guard; W. G. Prasse, Post board member; Hubert Barnes, Post board member.

Also Lieut. Col. J. R. Mills, Jr., chief, Industrial Operations Division, Department of the Army, Chicago Ordnance District; E. J. Biever, Kohler, Wis., Post board member; Capt. J. M. McDowell, commanding officer, N.R.O.T.C. unit, Marquette University; Capt. J. M. P. Wright, Washington, Staff Director, A.O.A. Post Operations.

Propellants And Explosives Section, Materials Division, Meets At Picatinny Arsenal

A meeting of the Propellants and Explosives Section, Materials Division, was held at Picatinny Arsenal, Dover, N. J., on April 8th-9th. Section Chairman T. E. Rafferty, E. I. du Pont de Nemours & Company, Wilmington, Del., introduced Col. Albert J. Weinnig, director, Feltman Research and Engineering Laboratories, Picatinny Arsenal, who explained the functions of the arsenal.

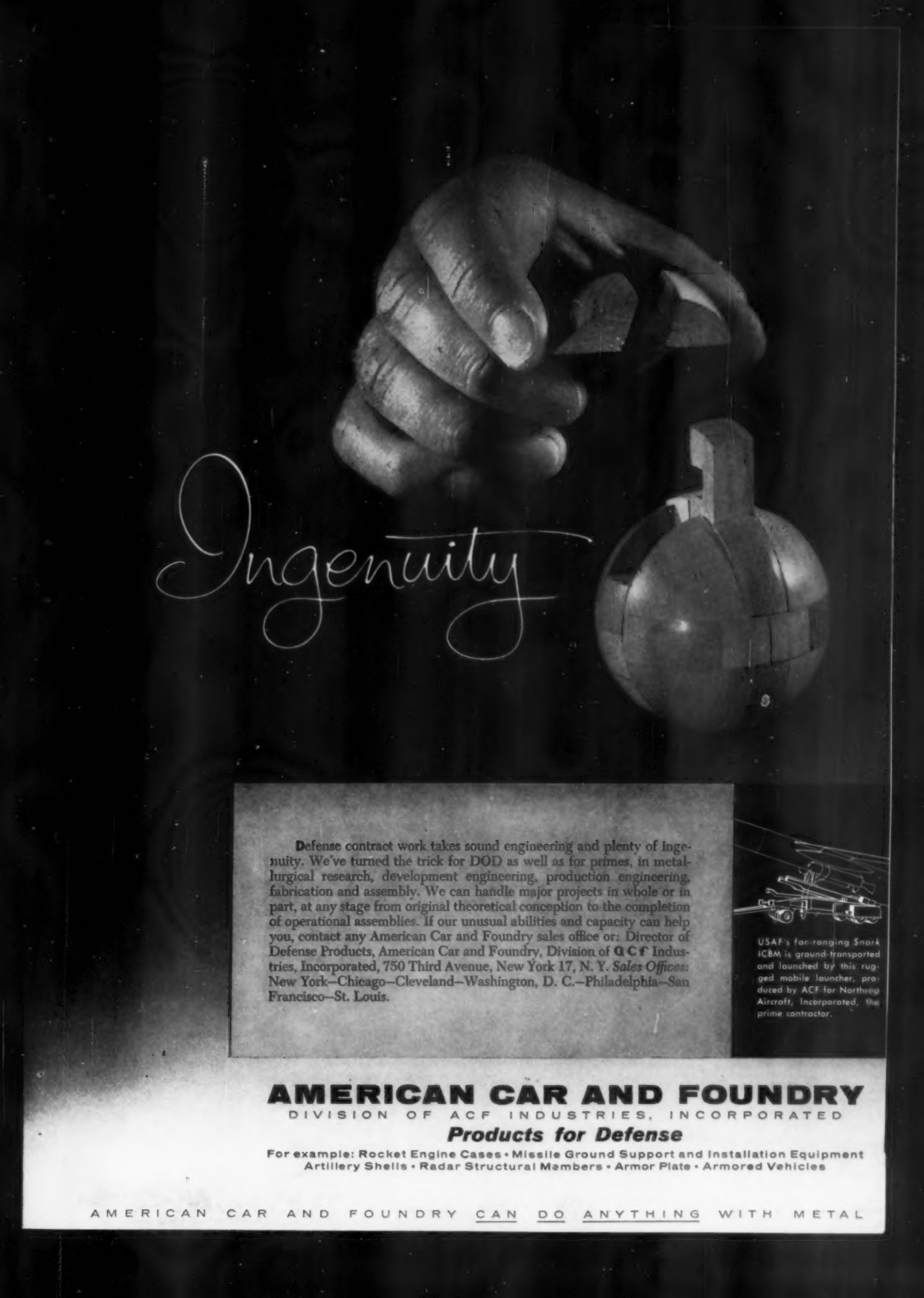
The organization of the U. S. Army Ordnance Special Weapons and Ammunition Command, Picatinny Arsenal, was outlined by Maj. Gen. Robert G. Butler. He stated that this separate Command was established for both atomic and conventional ammunition.

The conventional explosives and propellant program at Picatinny also was discussed, indicating that fundamental work is still required to cover all the chemical and physical aspects of any new items. Through research a new high explosive has been developed which has very good high-temperature properties. Additional technical papers presented were: "Continuous Processing of TNT," C. H. Madsen, U. S. Rubber Company, New York, N. Y.; "Combustible Cartridge Case Developments," Dr. A. E. Thrailkill, Aberdeen Proving Ground, Md.

"Army Programs on Solid Propellants," by J. H. Cox, Redstone Arsenal, Redstone, Ala., covered various propellants and binders and the resultant specific impulses. New developments include new polymeric materials as well as some of the newer exotic fuels.

The Navy propellant programs were discussed in two talks: "High-Performance Propellants," by C. N. Bernstein, Bureau of Ordnance, Washington, D. C.; "Temperature-Resistant Propellants," by

(Continued on p. 86)



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E. E. Katcher, Bureau of Ordnance, Washington, D. C.

"The Place of Solid Propellants in the Space Program," was outlined by E. Mitchell, National Aeronautics and Space Administration. He stated that a large part of the NASA program is based on liquids and that solid fuels would be used for upper stages in space probes. He also pointed out that the cost of solid propellants in many cases is higher than liquid engines.

Dr. G. V. Mock, Advanced Research Projects Agency, Department of Defense, defined the "ARPA Solid Propellant Program." It is planned to improve the specific impulse, increasing the payload and decreasing cost. A representative from Picatinny Arsenal reported on the work that is being performed on double-base plastisol-bonded propellants.

A talk entitled "Novel Rocket Propellant," given by Dr. Thrailkill described a new rocket propellant involving a cross-linked matrix of two polymers with the conventional oxidizers and additives.

Four technical papers were presented on the morning of April 9th: "Status of High-Performance Double-Base Engines," A. F. Ciacco, Hercules Powder Company, Wilmington, Del.; "Aerojet Composite Propellants," Dr. J. H. Wiegand, Aerojet-General Corporation, Sacramento, Calif.; "Current Problems in Solid-Propellant Development," N. Bassin, Thiokal Chemical Corporation, Trenton, N. J.; "Olin Mathieson Propellant Development Programs," Dr. Eugene Miller, Olin Mathieson Chemical Corporation, Marion, Ill.

Following the technical session, the Propellants and Explosives Section members held a meeting to discuss the relationship of this Section to the Propulsion Section of the Missiles and Astronautics Division. The 2-day meeting concluded with a tour of Picatinny Arsenal.

Comdr. E.P. Huey Is Guest Of Honor At Meeting Of Chattanooga Chapter

The Chattanooga Chapter of the Tennessee Valley Post was host on Friday, May 8th, to Comdr. Enders P. Huey, training officer for Commander Submarines Atlantic Fleet, at the spring meeting in the Chattanooga Country Club.

The program was opened with an invocation by Dr. James L. Fowle, pastor of the First Presbyterian Church. The presiding officer, H. F. Torok, Chapter chairman, described the significant manner in which the American Ordnance Association is of value both nationwide and in the Chattanooga area and called on Rear Adm. A. F. Richardson, vice-chairman, to be toastmaster of the meeting.

Commander Huey was introduced by Samuel R. Parry, vice-president, Combustion Engineering Company. The commander gave a brief background of past submarine development and employment.

He described the capabilities and flexibility of the new underwater hull shapes powered by nuclear engines as exemplified by the recently commissioned SKIPJACK. Commander Huey also touched on the need for submersibles as antisubmarine vessels and the great value of the Polaris-launching submarine as a deterrent and retaliatory weapon.

At Chattanooga, seated, l. to r.: S. R. Parry, Combustion Engineering, Inc.; Comdr. E. P. Huey, guest speaker. Standing, l. to r.: H. F. Torok, Chapter chairman; Rear Adm. A. F. Richardson, toastmaster; R. W. Cuthill, Tennessee Valley Post president.

During interludes of the meeting the famous Chattanooga Boys' Choir, youngsters from nine to fourteen years of age, rendered vocal selections.

Dr. Herbert F. York Is Guest Of Honor And Main Speaker At Washington Post Meeting

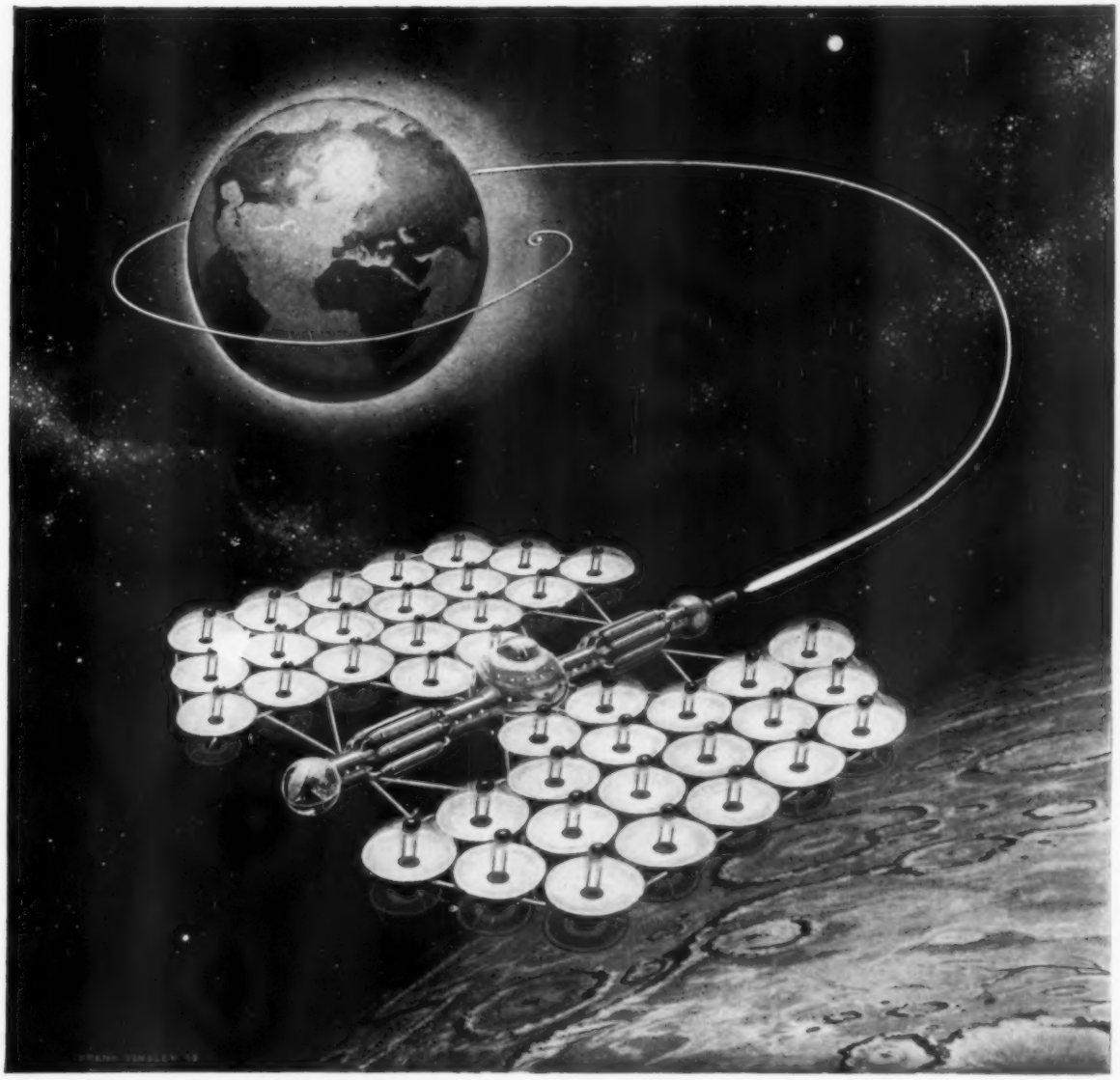
At the Washington Post's monthly luncheon meeting on Thursday, April 16th, over 150 A.O.A. Post and Division officials from all parts of the country joined the local members to honor Dr. Herbert F. York, Director of Research and Engineering, Defense Department, the guest speaker.

Distinguished guests at the head table were introduced by Ernest A. Tupper, Post president. They were: Capt. E. A. Ruckner, U.S.N., Assistant Chief, Navy Bureau of Ordnance for Research and Development; Brig. Gen. C. W. Clark, Assistant Chief of Army Ordnance, Research and Development; Rear Adm. W. F. Raborn, Director, Special Projects, Navy Bureau of Ordnance; Rear Adm. A. G. Mumma, Chief, Navy Bureau of Ships; Henry N. Marsh, A.O.A. vice-president in charge of Technical Divisions and Sections; Maj. Gen. Marshall Stubbs, Chief Chemical Officer of the Army; Vice Adm. J. T. Hayward, Deputy Chief of Naval Operations, Development.

Also, Maj. Gen. M. C. Demler, Director of Research and Development, Air Force Headquarters; Rear Adm. Rawson Bennett, Chief of Naval Research; Lieut. Gen. V. J. McCaul, Assistant Commandant, headquarters, U. S. Marine Corps; Lieut. Gen. A. G. Trudeau, Chief of Army Research and Development; Lysle A. Wood, director, A.O.A., and vice-president, Boeing Airplane Company; Dr. William H. Martin, Director of Research and Development, Department of the Army; Louis Polk, president, A.O.A.; John B. Macauley, Deputy Director of Defense—Research and Engineering.

Also, Vice Adm. G. F. Hussey, A.O.A. director; Hon. Courtney Johnson, Assistant Secretary of the Army (Logistics); Maj. Gen. R. L. Maxwell, A.O.A. director; Vice Adm. John H. Sides, Director, Weapons Systems Evaluation Group, Department of Defense; Maj. Gen. J. H. Hinrichs, Chief of Army Ordnance.

Also, Rear Adm. P. D. Stroop, Chief, Navy Bureau of Ordnance; Maj. Gen. F. A. Hansen, Chief, Field Service Division, Office of the Chief of Army Ordnance; Rear Adm. E. J. Peltier, Chief, Navy Bureau of Yards and Docks; Henry T. Luria, A.O.A. national vice-president in charge of Posts and Chapters; Rear Adm. T. A. Ahroon, Assistant



STEPS IN THE RACE TO OUTER SPACE

Cosmic Butterfly

Spreading its wings to absorb the eternal flow of solar energy is the Cosmic Butterfly, a space vehicle of a type first conceived by Dr. Ernst Stuhlinger of Redstone Arsenal.

Each of the fifty-foot parabolic mirrors in the wings concentrates the Sun's rays on a boiler at its focal point. Steam is developed, which drives a 200-kw turbo-generator in the base. Cooled by frigid outer space in heat diffusers, the steam reverts to water and is pumped back to the boiler to be used over and over again.

The current thus generated drives the main propulsion unit, an ion rocket in which powerful electric fields accelerate charged particles, shooting them from the rear of the rocket exactly as the electron gun in your TV set bombards the screen. Sunlight, then, is the power source, whereas cesium is the propellant.

While the recoil thrust is relatively small, the weightless vehicle is operating in a vacuum and the push is enough to enable the Butterfly to reach interplanetary speeds. Unlike conventional rockets, the Butterfly is under power the entire trip. Half way to its destination it turns around, and the ion thrust is used to slow the craft down to arrival speeds.

Since its thrust is entirely inadequate to cope with the gravity of major planets, the Cosmic Butterfly never lands. It is assembled in space and shuttles between artificial satellites.

The Cosmic Butterfly could carry ten passengers and 50 tons of cargo from an Earth satellite to a comparable one orbiting around Mars in about one year of continuous travel.

Inertial navigation systems will play an increasing role in the exploration of outer space. **ARMA**, now providing such systems for the Air Force ATLAS ICBM, will be in the vanguard of the race to outer space. **ARMA** . . . Garden City, N. Y. A Division of American Bosch Arma Corp.

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Chief, Navy Bureau of Ordnance; Rear Adm. L. D. Coates, Assistant Chief for Research and Development, Navy Bureau of Aeronautics.

Also Brig. Gen. H. A. Boushey, Director of Advanced Technology, U. S. Air Force; Col. William E. Campbell, military assistant to the Assistant Secretary of the Army (Logistics); and Everett L. Baugh, general Chairman for A.O.A. Technical Divisions and Sections.

Dr. York said the job of defense research and development is to assure that we have the weapons to deter war if possible and win if a war is forced upon us. After enumerating the various classes of missiles he noted some continuing problems, such as increasing reliability of liquid propellants, improving materials for tanks and nozzles, reentry, and the development of exotic fuels.

In discussing air defense, Dr. York pointed out that although the Midas infrared detection system required satellites in space it was of interest to the Defense Department primarily as a ballistic missile early warning system and should be budgeted in the latter category.

He observed that glamourizing missiles and rockets was probably necessary to get support but caused other programs of like importance to suffer. Among these he included the equipment for small wars such as transport, assault vehicles, armor, communications, food handling, and medical research. Dr. York enlarged on the developments in these fields and then issued a plea for basic research. He said it must be orderly but undirected and mentioned oceanography and solid-state physics as relatively unexplored fields for fruitful exploration.

Rochester Declares "A.O.A. Day" As Empire Post Hears Senator Saltonstall

May 15, 1959, was proclaimed American Ordnance Association Day by Rochester's Mayor Peter Barry as a tribute to the Empire Post on the occasion of its annual dinner meeting. The mayor's proclamation singled out the organization as "an active, alert, and skilled group of citizens united for the advancement of scientific and industrial armament preparedness."

Commenting on the proclamation, John J. O'Neil of Cornell Aeronautical Laboratory, Inc., Empire Post president, stated: "We hope that, by contributing to the strength of our national security and the maintenance of peace, our organization will be counted a staunch ally by our armed forces."

Senator Leverett Saltonstall of Massachusetts addressed the dinner meeting of 400 Empire Post members and guests on legislative aspects of defense procurement.

A high light of the meeting was the presentation of the Army Patriotic Civilian Service Award to Col. Charles F. Mosher, retired chief of the former Rochester Ordnance District. The award was made by Brig. Gen. John W. Cave, Assistant Chief of Ordnance for Program Coordination, on behalf of the Secretary of the Army.

Presently chairman of the board of Henderson-Mosher, Inc., Colonel Mosher joined the New York National Guard in 1906 and saw action in World War I. Recalled to active duty in World War II, Colonel Mosher commanded the Buffalo suboffice of the Rochester Ordnance District and after retiring in 1949 became civilian chief of the District until 1958.

Brig. Gen. John W. Cave, Assistant Chief of Army Ordnance, left, congratulates Col. Charles F. Mosher, retired chief of the former Rochester Ordnance district.

Claude G. Wright of Page Airways, Inc., past president of Empire Post, received an A.O.A. scroll in appreciation of faithful service. The award was made by Capt. J. M. P. Wright, of the Association's Washington headquarters.

During the course of the meeting congratulatory telegrams from Sen. Kenneth B. Keating (N.Y.) and Louis Polk, president of A.O.A., were read by Toastmaster Lee H. Orpin, chairman of the Post's Rochester Chapter.

In his address Senator Saltonstall stated: "I would say that there is a good deal more right than there is wrong with the governmental procedures whereby the United States seeks to carry out its defense efforts. However, neither as a longtime politician nor as a spokesman generally supporting the Administration on defense matters in the Senate, would I seek to persuade you that these processes whereby our military requirements are identified, determined, and procured are beyond improvement. Quite to the contrary, in fact, I see much that could be improved and have filed legislation which I think will make improvements. . .

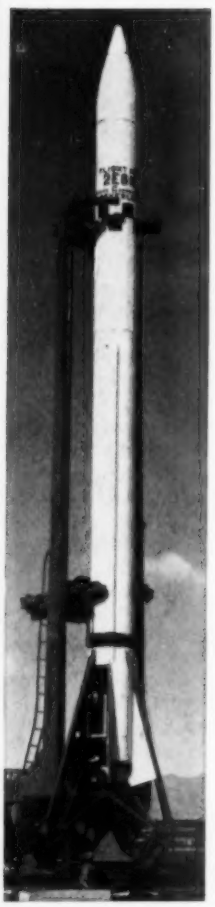
"If new weapons development is to keep pace with our critical space-age needs, procurement processes must be accelerated. We must discard obsolete requirements and restrictions which not only slow down the development of modern weapons but also are a drain upon engineering and administrative resources, both in government and industry, and upon the taxpayer's dollars. . .

"I have introduced a bill, S.500, in this session of Congress which is the result of many months of study and consultation with experienced persons both in government and private industry. I believe it offers some constructive improvements. S.500 would remove many of the impediments and restrictions in the present law. . .

"It gives me great satisfaction to see so many of you here, at it demonstrates great interest on the part of American industry in our national security. The job which I have outlined, that is, the determination and the execution of military requirements, is too large a task for either the Congress or the Administration, or both. It is a job which requires the full cooperation of enlightened citizens."

Other distinguished members and guests at the speakers' table were: Councilman Frank Horton, representing the City of Rochester; Ralph F. Peo, Houdaille Industries, Inc., director emeritus of the Post; H. Follett Hodgkins, Lipe-Rollway Company, first vice-president of the Post; John H. Bouman, Ansco Division, General Aniline & Film Corporation, second vice-president of the Post.

(*Continued on p. 90*)



Bring a friend to Aberdeen

on

ordnance day

October 8, 1959

The Forty-first Annual Meeting of the American Ordnance Association will be held at Aberdeen Proving Ground, Maryland, on Thursday, October 8. Guided missiles, rockets, tanks, guns, fire control, and other modern armament will be displayed and tested for A.O.A. members.

Bring an interested friend. If he is not an A.O.A. member have him send in this application right away. (*To attend he must be a member and have an Ordnance Day reservation by September 30th.*)

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Don't Miss the A.O.A. Annual Meeting October 8

Also, Brig. Gen. John W. Cave, Assistant Chief of Ordnance for Program Coordination; Col. Hans G. Jepson, commanding officer, New York Ordnance District; Lieut. Col. W. Bruce Loomis, commanding officer of the Rochester Regional Office of the New York Ordnance District and secretary of the Empire Post; Dr. Philip Johnson, chaplain; Col. A. S. Young, commanding officer of the Rochester Air Procurement District and a Post director; and Capt. Gordon Uehling, U.S.N., staff, Joint Chiefs of Staff.

In addition to General Chairman Lee H. Orpin, other members of the committee arranging the annual dinner meeting were: Raymond M. Biehler, Howard M. Duffy, Earl T. Gruendike, Carl S. Hallauer, Lee W. Hiatt, Lieut. Col. W. Bruce Loomis, Col. Charles F. Mosher, Thomas H. Robinson, Claude G. Wright, Col. A. S. Young, and Mrs. Evelyn S. Brown, assistant secretary, who coordinated the functions of the committees.

General Medaris Is Guest Of Honor At Annual Meeting Of St. Louis Post

The 1959 annual meeting of the St. Louis Post was a brilliant affair in every respect. The honor guest and principal speaker was Maj. Gen. John B. Medaris, Commanding General, U. S. Army Ordnance Missile Command. He spoke on "Army Missile Management"—a timely statement of the philosophy which has guided the Ordnance Corps of the Army, in cooperation with American industry, so successfully over the years in the development of weapons. General Medaris' address is printed in full on page 49 of this issue of ORDNANCE.

A. J. Mummert, president, McQuay-Norris Manufacturing Company, who was completing his term as president of the Post; and his newly elected successor, W. R. Persons, president, Emerson Electric Manufacturing Company, gave stirring addresses on the responsibilities and needs for scientific and industrial cooperation in solving our current weapons-preparedness problems.

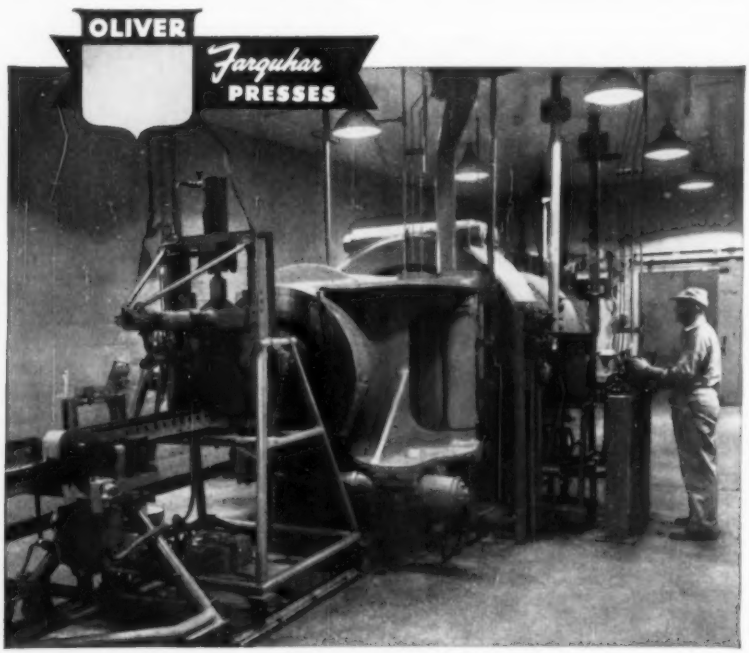
The invocation was given by Lieut. Col. Daniel V. Campbell, S.J., of St. Louis University, a member of the Air Force Reserve. Col. Leo A. Codd, executive vice-president of the Association at Washington, also addressed the meeting.

A notable company which filled the ballroom of the Sheraton-Jefferson Hotel was present with more than 500 members and friends being seated for dinner. This was the thirty-second birthday of the Post, and the enthusiasm which prevailed attested to the strength of the organization and the widespread support it has throughout the important St. Louis industrial area.

The newly elected Post officers for the coming year, in addition to Mr. Persons, are: Warren Drake, McDonnell Aircraft Corporation, vice-president; W. P. Gatley, National Rejectors, Inc., treasurer; and Thomas J. Coll, St. Louis Ordnance District, secretary.

Directors to serve for two years are: Mr. Mummert; Maj. Gen. L. J. Sverdrup of Sverdrup & Parcel; Erwin P. Stupp, Stupp Brothers Bridge & Iron Company; Aaron Fisher, Universal Match Corporation; W. A. Morse, St. Louis Ordnance District; and Edwin P. Meissner, Jr., St. Louis Car Company.

Directors to serve for one year are: C. P. Whitehead, General Steel Castings Company; T. W. Pettus, Scullin Steel Company; Vincent P. Ring, Knapp-Monarch Company; George W. Brown, Wagner Electric Company; F. Gano Chance, A. B. Chance Company, Centralia, Mo.; Marvin W. Swain, Alton Box Board Company. Ex-officio members of the board of directors are: Lieut. Col. H. E. Greuter, commanding officer, St. Louis Air Procurement District; Lieut. Col. Norman C. Pardue, commanding officer, St. Louis Army Ordnance District; Comdr. Nathan F. Asher, inspector of naval materials.



At Astrodyne's plant in McGregor, Texas, this Oliver-Farquhar 2140-Ton Hydraulic Extruding Press does its work in the silence of its own cell, compacting today's powerful solid rocket propellents. All movements of this unique press are programmed and recorded in a central control bunker placed at a safe distance from the unmanned press cell.

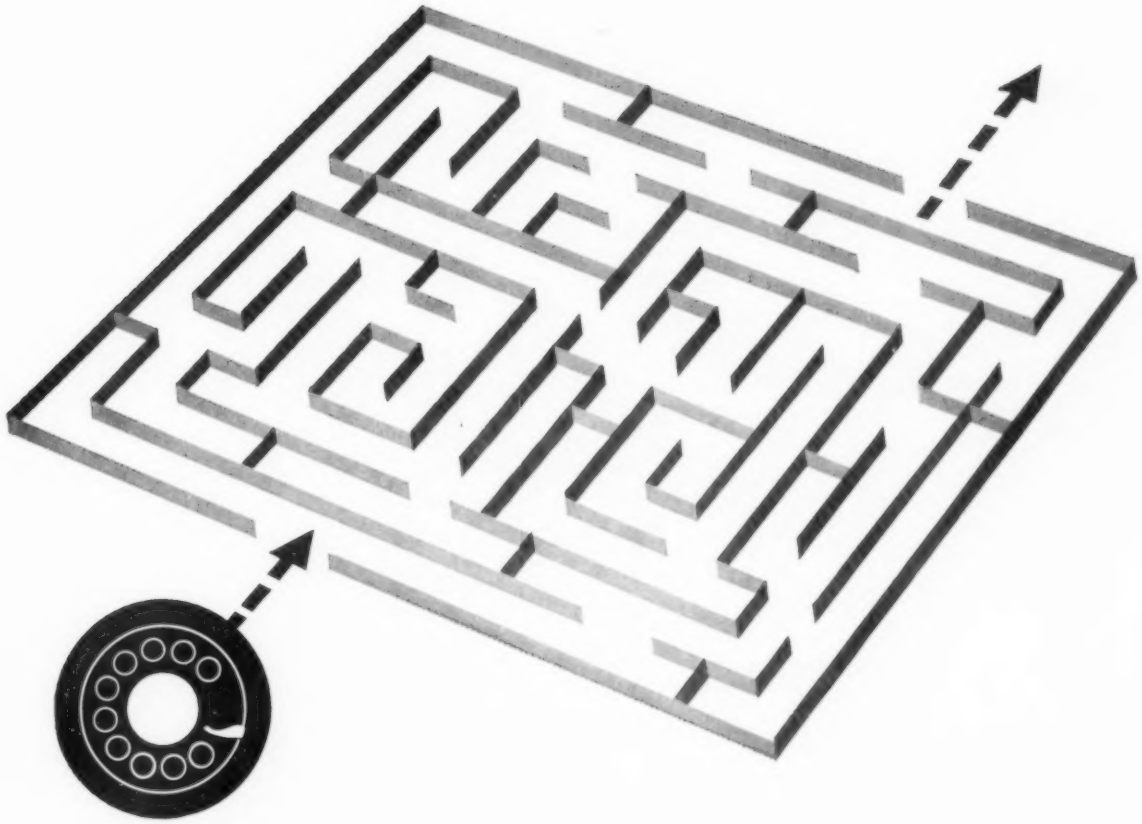
Write, wire or phone for complete information or ask for our recommendations and proposals. The Oliver Corporation, A. B. Farquhar Division, Press and Special Machinery Departments, York 4, Penna.

Record Crowd Greets General Schomburg As Dixie Post Meets At Fort Eustis Officers' Club

A record crowd turned out for the Dixie Post meeting on March 16th at the Fort Eustis (Virginia) Officers' Club. Over 300 members gathered to greet Maj. Gen. August Schomburg, Deputy Chief of Army Ordnance, the guest of honor.

An added attraction was a display of antique small arms from the collection of M. A. Friedman, Jr., of Hampton, Va., along with an exhibit of the Army's

(*Continued on p. 94*)



Automation cut its teeth on the telephone

...how ITT's early work in telephony aided the advancement of automation

The dial telephone exchange was one of the first examples! Today, automatic switching and new electronic techniques for automation are altering the operations of virtually every business and industry.

It was natural that ITT System companies, pioneers in the first, should be leaders in the second.

Customers have ranged from mail-order houses, railroads, libraries and oil companies to the air forces of several NATO governments.

There have been dramatic results.

One example is the automatic check-processing system developed by ITT System companies for one of the nation's largest banks. It codes, sorts and verifies checks. It performs all normal bookkeeping and accounting operations for demand deposits.

Another is the automation system for a large steel mill which records the program of requirements for every job, then feeds back information to production control centers as each phase is completed.

Still another: the first automatic U.S. post office, now under construction in Providence, Rhode Island.

Hundreds of others could be cited. Each required a complete understanding of automation from the design of a simple switch to the functioning of a fully-integrated electronic complex.

The ITT System has many specialists in this field. Among them: Intelex Systems Incorporated in retained-document automation; Kellogg Switchboard and Supply Company in automatic switching; Airmatic Systems Corporation in automatic-switch pneumatic tube and document conveyor systems; and ITT Federal Division in automatic test equipment, both military and industrial. ITT's European subsidiaries add to this experience.

To learn more about ITT's abilities in the area of automation, write for further information.

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STANDARD ELECTRIC CORPORATION • LABORATORIES AND MANUFACTURING PLANTS IN 20 FREE-WORLD COUNTRIES

NEW AVCO RESEARCH CENTER

Space age research gets a new headquarters

One of the largest and best-equipped research facilities in the nation is the new 16-million-dollar Avco Research Center at Wilmington, Massachusetts. Here, research and development in space age technology is already being conducted in areas ranging from missile re-entry to satellite design. From work such as this—and equally important work at the nearby Avco Research Laboratory—will come further contributions to national security and the conquest of space!

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new M14 rifle and M60 machine gun and some World War II weapons.

Presiding Officer George Svadeba welcomed the guests, including Maj. Gen. N. H. Vissering, commanding general of Fort Eustis, and top officials of the Newport News Shipbuilding and Drydock Company.

General Schomburg entranced his audience with a description of new developments in Army equipment designed to increase the efficiency of our soldiers. He also noted how many of the items developed for the Army could be useful to civilians.

Powder Metallurgy Section Meets At Wright-Patterson Air Force Base, Ohio

The Powder Metallurgy Section of the A.O.A. Materials Division held its regular spring meeting at Wright-Patterson Air Force Base, Ohio, May 14th, with Chairman A. J. Langhammer presiding. Members were apprised of the latest results of the efforts of the Section to be more useful to the Defense Establishment through closer cooperation with all interested installations, not only during meetings but on a continuing basis.

Powder Metallurgy Section officials and guests assemble before the spring meeting of the Section held at Wright-Patterson Air Force Base, Ohio.

The results obtained by the Division Task Force, consisting of engineers from several arsenals under the chairmanship of R. H. Ridgway, Ordnance Ammunition Command, Joliet, Ill., were reviewed. In reporting the latest advances in the powder-metallurgy industry, special emphasis was placed on the growing role of titanium and beryllium parts and on the unique advantages of the powder-metallurgy method for the production of economical nuclear-fuel elements.

The increasing value of this kind of cooperation was expressed by Maj. Gen. E. P. Mechling, A.O.A. Staff Director for Technical Operations. Brig. Gen. W. K. Ghormley, commanding general, Ordnance Weapons Command, Rock Island, Ill., stressed the need for constant study of new applications of the powder-metallurgy art to existing as well as to new ordnance equipment. He explained that this kind of study is best carried out by informed engineers with the kind of specialized background knowledge which the Task Force members have been able to obtain through an organized program of visits to producing powder-metallurgy installations.

Representatives of the High Temperature Materials Section, Wright-Patterson Air Force Base, who were hosts for the meeting, emphasized the importance of powder metallurgy in the adaptation of refractory metals to high-temperature problems and demonstrated their own competency in the application of the process in this area.

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Write for Bulletin 8600-O

Annual A.O.A. Awards Are Presented To Outstanding Cadets at Texas A. & M.

The Texas A. & M. Chapter of the Lone Star Post was proud to report that three A.O.A. awards were given at the Mother's Day Presentations with the entire Corps of Cadets, 5,000 strong, massed in a full-dress parade on May 3rd.

Cadet Lieut. Col. Thomas E. Reddin of Texarkana, Tex., received the A.O.A. scholarship key and certificate. Cadet Reddin was a distinguished student in electrical engineering, the corps adjutant, and a member of the Ross Volunteers, an honor

Thomas E. Reddin

Philco Ground-Space Communications System commands and tracks **DISCOVERER** satellite

DISCOVERER . . . the United States' newest earth satellite . . . is opening new vistas on the frontier of outer space. And Philco is proud to play an important role in this renowned achievement as a part of the Discoverer Team . . . in conjunction with the Lockheed Aircraft Corporation and the Air Force at the direction of the Advanced Research Projects Agency of the Department of Defense.

As the subcontractor for Discoverer's entire communications system, Philco designed and developed the vast complexity of ground-space communications, tracking, commanding and data gathering and processing systems.

The Philco-designed and equipped system observes and commands Discoverer through a series of five tracking and data collection stations in Alaska, California, Hawaii and a specially equipped ship at sea. Philco continues its participation in the Discoverer Program by assisting in the actual operation and maintenance of the communications and data handling network.

Philco's part in the Discoverer Program is typical of the many and diverse advanced research and development activities being conducted in our laboratories on the East and West Coasts where outstanding career opportunities abound for Engineers, Mathematicians, and Physicists.

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Maj. Gen. Nelson M. Lynde, Jr., center, host to an A.O.A. seminar at the Detroit Arsenal during Armed Forces Week, inspects the official A.O.A. emblem given to new members at the Association's booth. The ladies who "manned" the booth are, left to right: Eleanor Piwinski, Janet Schonschack, Donna Presley, Margaret Bryan, Elaine Nizol, Sharon Francis, Betty Dowd, and Judy Johnson. All are employees of the Ordnance Tank-Automotive Command and the Detroit Arsenal.

military group. He was president of the Texas A. &. M. Chapter of the American Ordnance Association and a member of several scholastic honor fraternities.

Cadet Reddin also received the Sons of American Revolution Award for the outstanding junior in ordnance at Texas A. & M. in 1958 and was a member of the student senate and Student Conference on National Affairs. Upon graduation he was commissioned a 2nd lieutenant in the Ordnance Corps of the Regular Army, and reported to Fort Sill, Okla., for his first assignment.

Medals for outstanding contributions to the student Chapter of A.O.A. were presented to Cadet Maj. James W. Best and Cadet Capt. Jack N. McCrary.

Cadet Best, of Fort Worth, Tex., was a battalion executive officer and vice-president for committees of the Texas A. & M. Chapter of A.O.A. He was president of the Aggie Players, a theater group that presented many plays at A. & M. He also was a member of the Speechmasters, the Marketing Society, and the Arts & Sciences Council. Cadet Best was graduated with a degree in business administration and will report to Aberdeen Proving Ground in October 1959 as a 2nd lieutenant in the Ordnance Corps.

James W. Best

Cadet McCrary, of Midland, Tex., was designated a distinguished military student and was an officer in the Ross Volunteers. He was vice-president for activities of the Texas A. & M. Chapter, an outstanding cadet at summer camp, and commander of an Ordnance company. He also was chairman of the Student Conference on National Affairs, and a member of A.S.M.E. Cadet McCrary was graduated with a degree in mechanical engineering and will report to Aberdeen Proving Ground in January 1960 as a 2nd lieutenant in the Ordnance Corps.

J. N. McCrary

The Texas A. & M. Chapter is assigned to the Lone Star Post since the officers and directors of that Post were instrumental in establishing the Chapter. It is the largest and most active of the student Posts and Chapters in the A.O.A., averaging over 150 members.

Texas A. & M. College is one of the five remaining institutions where there is a special R.O.T.C. Ordnance unit, whereas many other such famous Ordnance units have been merged in the R.O.T.C. general-service program.

The cadet corps at this university has contributed more officers to the U. S. Army than any similar college in the country.

(*Contd. on p. 98*)

ARMY MOBILITY AND FIREPOWER NEW VOUGHT STUDY AREA

Chance Vought has taken the volunteer's pace forward to work with the Army in an important mission . . . bringing new techniques to an ages-old defense area – the battlefield.

For 42 years a developer of high-performance aircraft and strategic missiles, this company has sharpened its focus on the needs of the new Army.

On its own initiative, Vought has engaged in new study and development programs to meet requirements of the Army of today and tomorrow. One new concept, still classified, was tested early in 1959 at the Army's Redstone Arsenal.

Design philosophies and an organization tailored to development of advanced aircraft and superior missiles are being adapted to the battlefield needs of total mobility and devastating firepower.

Vought's talents will continue to be directed toward fulfilling the requirements of our modern Army.

Advanced weapons is just one in the broad spectrum of Chance Vought fields of activity. Other areas include: design and production of high-performance aircraft, astronautics, electronics, anti-submarine warfare, range systems management, commercial process control systems.

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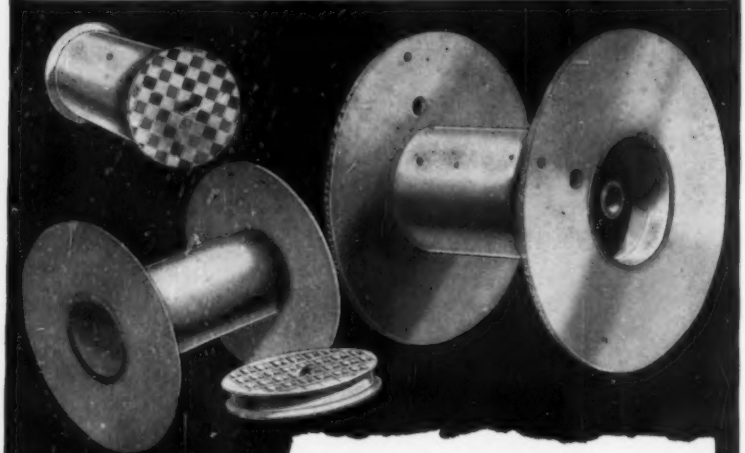

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Executive Board of the Fire Control Instrument Division Discusses Future Program

An Executive Board meeting of the Fire Control Instrument Division convened on April 14th in Washington, D. C. Division Chairman Dr. W. L. Barrow, Sperry Gyroscope Company, Great Neck, N. Y., conducted the meeting.

Because of the diversity of subject matter within this Division, it was decided not to have a regular meeting of this Division. Instead, Executive Board meetings will be held and, in some instances, joint meetings for related Sections.

Each Section chairman or his representative made a report of the status, activities, and plans of his Section.

Warren H. Young, Bulova Watch Company, Flushing, N. Y., secretary, Instrument Jewel Bearing Section, reported that jewel bearings for watches are no longer being made by American manufacturers. Present quantities for military uses also are small, largely for a declining flight-instrument business and for gyros for missiles. Uniform standards of dimensions are also nonexistent as are standards of inspection. Preliminary work has to be done before a Section meeting so that definite progress can be assured.

James P. Gillilan, General Motors Corporation, Bristol, Conn., chairman, Instrument Precision Ball Bearings Section, stated that this Section has had little success in furthering the standardization of ball bearings. It also has been difficult to obtain uniform methods of torque testing. One achiement of this Section is their participation in the Government development of a reference torque testing machine. A subcommittee on bearing dimension standardization also has met. The principal problem facing this Section is the current lack of interest on the part of the military, resulting in a complete lack of problems.

Dr. Carlton W. Miller, Perkin-Elmer Corporation, Norwalk, Conn., Test Range Instrumentation Section, is chairman of this Section, one of the most active within the Division. There have been a sequence of successful meetings of this Section at various test ranges. The principal task of this Section is the location of specific problems of vital interest to the military.

Richard D. Lorbach, Eastman Kodak Company, Rochester, N. Y., also stated that there has been little activity on the part of the Optical Section because of a lack of Government problems. It was suggested that members of this Section might join the Test Range Instrumentation Section because of their work with optical target tracking. The Optical Section might expand its scope to include infrared spectrum and exotic materials in optics.

(*Continued on p. 100*)

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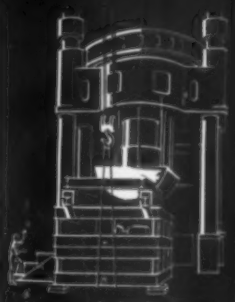

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Imparting these instincts to inanimate systems is the business of TI optics engineers and craftsmen. Leading designers and producers of silicon, germanium, quartz, and other optics for infrared applications, the TI optics team has fingertip familiarity with unusual materials suited to specific portions of the spectrum. In one of the nation's best equipped facilities, TI optics specialists grind, polish and coat components with accuracy that exacts the most from even the weakest infrared signal. This experience can work for you. Whatever your needs ... prisms, lenses, windows ... TI's full-time engineering service, modern computers, and complete optics facility can meet your requirements from design to delivery. For detailed information on any phase of precision optics technology, contact SERVICE ENGINEERING.

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Association Affairs (Contd.)

Herman O. Grimmeisen, Gilbert & Barker Manufacturing Company, West Springfield, Mass., chairman of the Mechanical Section, reported that the obsolescence of mechanical fire-control equipment has eliminated the need for this Section. Hugh C. Carroll, General Electric Company, Schenectady, N. Y., deputy chairman of the Division, suggested changing the scope of the Section to include sensors.

Dr. Barrow represented F. A. Christoffel, Hamilton Watch Company, Lancaster, Pa., chairman of the Watch and Clock Section. Since this Section has been unable to discover any problems from the military, it was agreed that the Section be dissolved with commendations on its past work.

Dan A. Kimball Addresses Spring Meeting Of Tennessee Valley Post At Huntsville

The spring dinner meeting of the Tennessee Valley Post was held at the Fort Raymond W. Jones National Guard Armory, Huntsville, Ala., on Friday, April 17th, when the members assembled in great numbers to greet the guest of honor, Dan A. Kimball, president of Aerojet General Corporation.

Robert W. Cuthill, Post president, was presented with checks for $5,000 from the Brown Engineering Company and the Human Resources Foundation, Inc., both of Huntsville. These checks were turned over by Milton K. Cummings, president of Brown Engineering and a vice-president of the Post, to support two college scholarships to be administered by the Tennessee Valley Post. The scholarships are reserved to youths who reside in the Post area and will be selected by a board appointed by the Post.

Mr. Kimball, a former Secretary of the Navy, spoke on "Missiles for Everybody's Arsenal." "I think," he said, "that all the services have got to have their own programs within reason and be allowed to go ahead with them. There may be some aspects of these programs which look like duplication, but I'm not as much worried about a little duplication here and there as I am about the chance of missing a good bet because somebody with a bright idea doesn't get the opportunity to develop it.

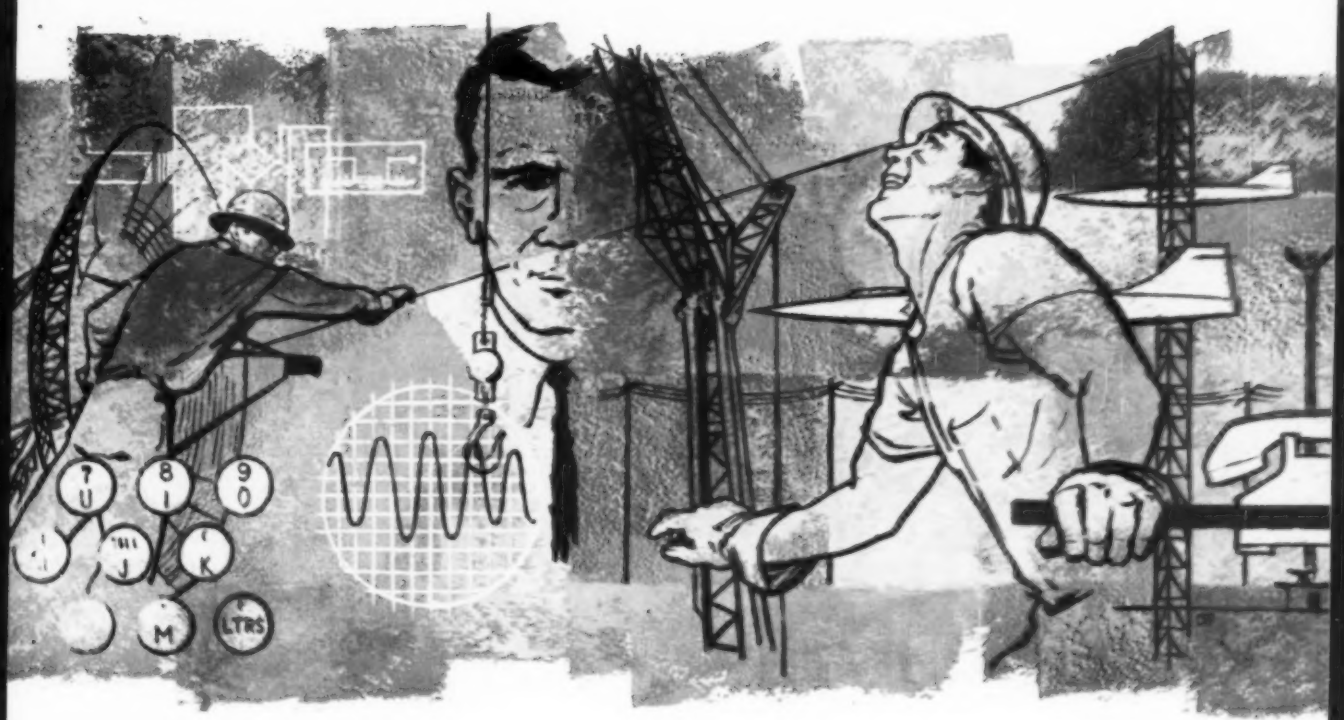
"Up to now, as far as I can see, all the services have done a good job and they're willing to exchange ideas that pay off when they will benefit another service."

In conclusion, Mr. Kimball stated:

"Our system is still the best one in the world, and that's why we have to see that it survives by building up our mili-

(*Continued on p. 105*)

ALPHA



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For a number of years, Collins has been engaged in a concentrated program of design, engineering and installation of complex communication systems for both military and commercial uses. This program has resulted in the development of technical skills, management techniques and know-how representing a significant addition to the company's primary activity of developing and manufacturing individual units of electronic equipment. Alpha has been formed to expand upon Collins activities in this field.

Alpha, with its highly specialized systems management organization of designers, engineers, scientists and constructors, will produce complete, packaged commercial and government installations in this country and abroad . . . using the best available equipment from industry to deliver to its clients turn-key installations meeting the highest standards of dependability and quality . . . ready for operation.

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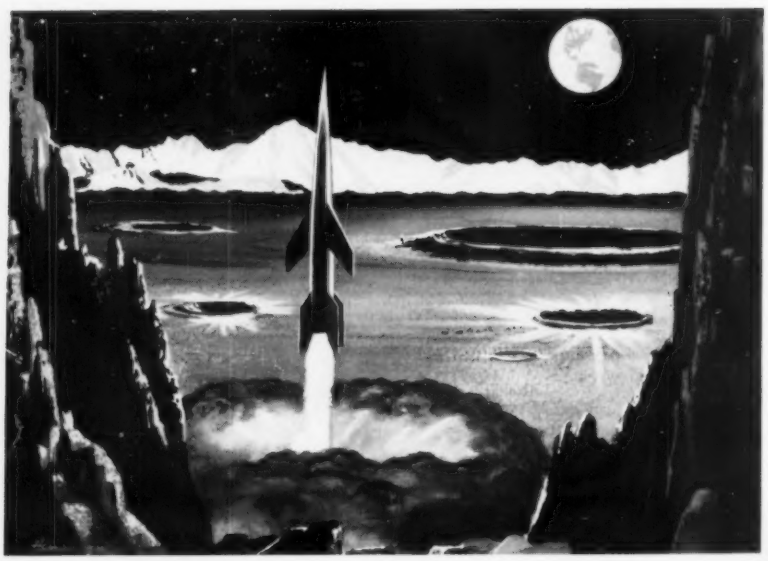

"MISSION ACCOMPLISHED: DEPARTING LUNA 2205 ZEBRA"

This message, flashed across a quarter-million miles to Washington, D.C., will be awaited anxiously by millions.

But even then our first expedition to the moon will still face its most crucial test—the journey home to earth.

The success of that trip will depend in large part on rocket propellants—fuels and oxidizers that will have been stored for days in the tanks of the expeditionary vehicle and yet will respond instantly when needed.

Storable liquid propellants is one of the fields in which Rocketdyne has anticipated the future. For more than ten years, its propellant chemists have been studying, engineering, and testing combinations of storable fuels and oxidizers for greater storability and higher energy.

Storability PLUS high energy

Rocketdyne has tested these combinations in all production and experimental engines. The results prove that today's storable fuels and oxidizers have these important capabilities:

(1) High performance, even after months or years of storage; (2) Stability over a wide temperature range, permitting storage in missile tanks without rigid environmental controls; (3) Dependable performance, predictable even at extremes of heat and cold; (4) Instant readiness for firing at any time during the storage period; (5) Energy yields equal to or higher than those of conventional propellant combinations.

Second-generation missiles

The tests also prove that engines developed for conventional propellants can be converted to storable combinations rapidly and inexpensively—a significant consideration in the development of second and third generation strategic, tactical, and air defense missiles.

Significant, too, is the *potential* performance of storable combinations. Research points to energy yields as high as 400 seconds of altitude specific impulse—performance 20 percent higher than that of today's combinations. These high-energy yields will offer new capabilities and greater flexibility for America's scientific and military programs.

Stepping stones to Space

Rocketdyne has designed and built much of today's operating hardware in the high-thrust rocket field. Engines by Rocketdyne power most of the military and scientific projects sponsored by Air Force, Army, and NASA. This experience now becomes the point-of-departure for tomorrow's journeys into the unknown.

POWER FOR AMERICA'S MISSILES

Thrust chamber production line for Thor and Jupiter at Rocketdyne's Neosho, Mo., facility moves smoothly.

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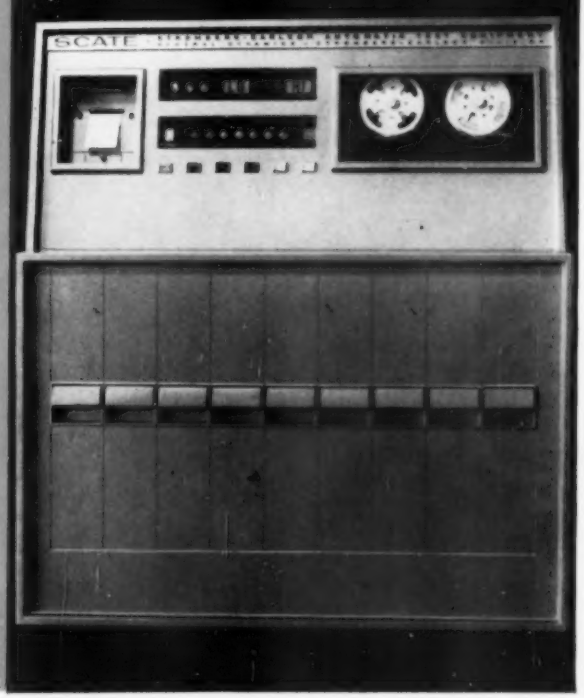

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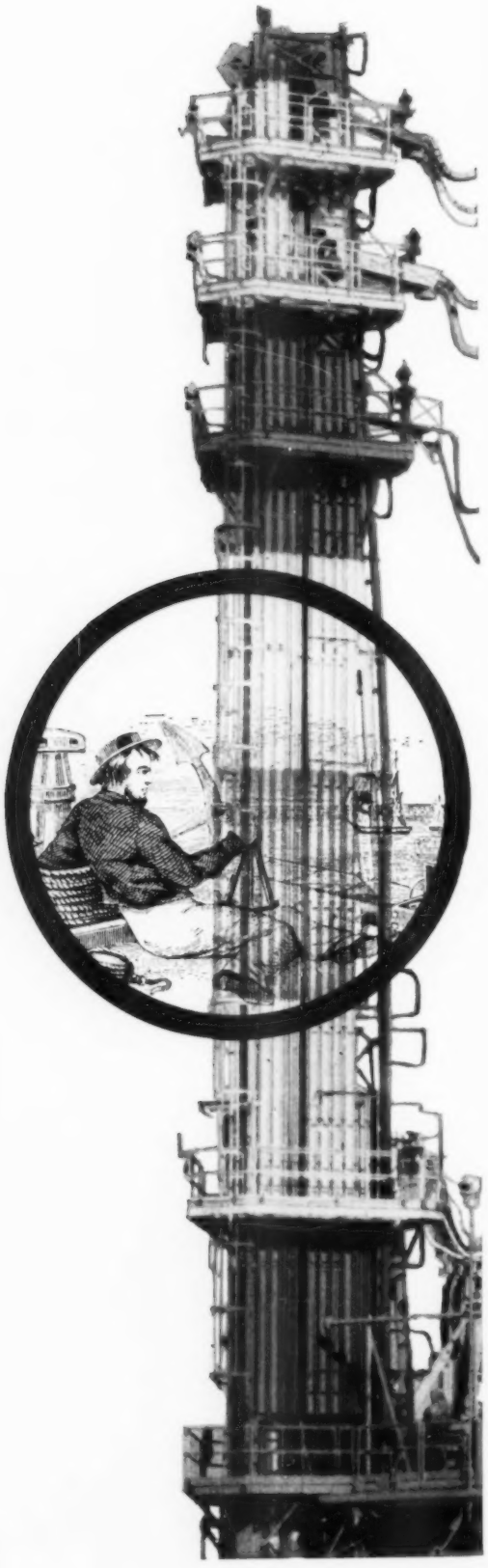


PORT OF EMBARKATION

In the decade of missilery ahead, prime contractor capability must go far beyond the requirements of hardware design and manufacture. New experience and facilities are now required in the increasingly critical launching phase—from ground handling and testing to countdown and data control.

Martin's Cocoa Division is the first organization of its kind devoted exclusively to this specialized area. Accomplishments have already established new operational standards at Cape Canaveral, one of the two U.S. ports of embarkation for the major space events of the decade ahead.

An example of the latest development in electronic fail-safe launching equipment is the new Martin Master Operations Control [MOC] system, which automatically monitors count-down procedures in the test firing of research and development-type TITAN missiles. With equipment such as this, TITAN launchings have achieved unheard-of performance reliability.

tary strength and never forgetting that progressive industry and agriculture and technology are the backbone of our national power.

"With that power evident and ready, we can meet the Soviets at the summit or anywhere else and be pretty sure that they will be willing to behave. I think it's the only way we can have peace."

Philadelphia Post Visits Bethlehem Steel Company, Presents J. C. Jones Award

The huge operations of the Bethlehem Steel Company at its Sparrows Point plant, Maryland, were the scene of the annual spring meeting of the Philadelphia Post of the Association on May 6, 1959. Some 400 members, led by Weber deVore, Post president, journeyed by special train from Philadelphia to the plant for a day-long program of tours, including a luncheon meeting. The officials of the company were hosts for the day, being led by C. T. Stott, general manager of the Sparrows Point plant.

The tours included the docks, open hearths and blast furnaces, 68-inch hot mill, 160-inch mill, rod, pipe, wire, and nail mills. All members were impressed by the size, complexity, and engineering applications evident on all sides.

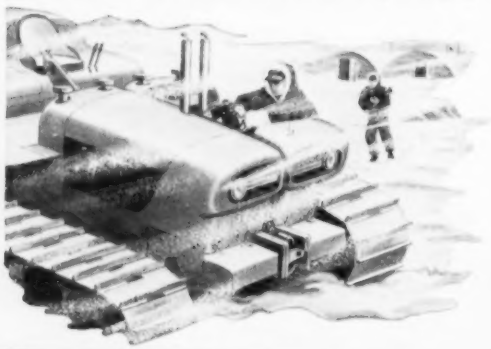
At the luncheon meeting the honor guest and principal speaker was Capt. Frederick L. Ashworth, U.S.N., director of the Atomic Energy Division, Office of the Chief of Naval Operations, Washington. The topic of his talk was "Nuclear Neurosis."

Captain Ashworth took a principal part in the development and delivery of the first A-bombs on their targets in World War II. He was promoted to the rank of rear admiral on May 14, 1959, a week after the meeting.

The John C. Jones Award presented annually by the Post was made to Col. Leo A. Codd, Association executive vice-president. The presentation was made on behalf of the officers and members of the Post by William J. Meinel, a director of the Post, and president of Heintz Manufacturing Company, a division of Kelsey-Hayes Company. The award was founded by the Philadelphia Post in 1945 and is in the form of an inscribed silver tray. An illuminated citation accompanied the award. The chairman of the Awards Committee was H. Paul Gant.

Seated at the speakers' table in addition to those already mentioned were: Joseph H. Gillies, Philco Corporation; George J. Burnham, U. S. Steel Corporation; Col. Albert W. Gilmer of Barnes, Dechert, Price, Myers & Rhoads; Brig.

HEAT in military applications



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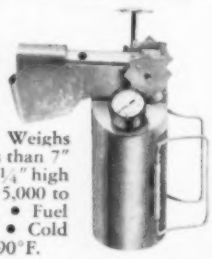
MODEL SPX 2
Meets field requirements for small and medium size engine starting, etc. • Weighs only 3½ lbs., less than 7" wide, 7½" long, 9¼" high • Output range 15,000 to 50,000 BTU/Hr. • Fuel capacity, 1 pint • Cold start as low as –90°F.



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Association Affairs (Contd.)

Gen. Burton O. Lewis, formerly staff consultant for A.O.A. Technical Divisions and Committees; Brig. Gen. David N. Hauseman, Davison Chemical Company; Henry N. Marsh, A.O.A. vice-president for Technical Divisions; Col. Joseph G. Duncan, III, commanding officer, Philadelphia Army Ordnance District; L. C. Allenbrand, Caterpillar Tractor Company; Horace C. Knerr, Metlab Company; William F. Rathgeber, Jr., secretary-treasurer, Philadelphia Post.

Election of officers and directors was announced by Mr. deVore, who, with the vice-presidents, will remain in office. New directors elected are: Walter N. Howley, Sr., president, Lansdowne Steel & Iron Company, and R. Stockton Taylor, Bethlehem Steel Company.

San Diego Post Receives Charter As Fortieth Unit Of Ordnance Association

Under the leadership of President Richard H. Meleney, the San Diego Post was inaugurated in the best A.O.A. tradition at the Admiral Kidd Club in San Diego on Tuesday, April 21st.

Members of this fortieth Post of the Association, formed from the San Diego Chapter of the Los Angeles Post, turned out almost 200 strong for the charter ceremony and to greet Dan A. Kimball, president of Aerojet-General Corporation, the guest of honor.

As the meeting was called to order, Mr. Meleney introduced the head-table guests and called on Lieut. Comdr. W. H. Woodson, past president of the Chapter and National Council representative. Commander Woodson presented the A.O.A. certificate of appreciation to David B. Acker of Convair, a founder of the Chapter and former chairman, whose great interest has helped to maintain a high degree of activity. (*Contd. on p. 108*)

• **The Annual A.O.A. Directory for 1959-1960 will be mailed about July 15, 1959, to the following: The national officers and directors, company members, members of Technical Divisions and Sections, officers and directors of local Posts. Any other A.O.A. member who wishes to receive a copy will be sent one on request.**

• **The Index to ORDNANCE, Vol. XLIII, also will be ready shortly. This is arranged alphabetically by subject and author, with title page for binding, and covers issues No. 229 (July-August 1958) to No. 234 (May-June 1959). It is available on request.**

• **Address: American Ordnance Association, Mills Building, Washington 6, D. C.**

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Robert C. Geffs, a regional vice-president of the A.O.A. who assisted in establishing the Chapter when he was president of the Los Angeles Post, welcomed his protégés to Post status and predicted a glowing future. The charter for the new Post was presented by Capt. J. M. P. Wright from A.O.A. Headquarters.

The last order of business was a report from the Post secretary-treasurer, Calvin P. Owen, who outlined plans for the coming year that include establishment of a Chapter in Phoenix, Ariz., and sponsorship by the Post of a museum of science for the San Diego area.

Mr. Kimball in his address spoke of the urgency for this nation to remain first in missilery. He noted that "first in accuracy" was the important criterion, not necessarily first in numbers—"we must strive to ensure that ten out of ten will hit the target."

The former Navy Secretary also reminisced about his own early flying experience when a 100-mile flight seemed as difficult as a space flight these days. He then expressed the hope that use of space vehicles for communications, weather, reconnaissance, and offensive action might be another step in preventing wars—again provided this country is first.

Other guests at the head table included Capt. R. C. Lynch, U.S.N., commanding officer, San Diego Naval Training Station; Rear Adm. Charles C. Hartman, commandant, 11th Naval District; Herbert Kunzel, president, Solar Aircraft Company; Rear Adm. R. H. Speck, commander, Amphibious Training Command.

The officers and directors of the Post are: Mr. Meleney, president; T. B. Field, vice-president; Mr. Owen, Secretary; C. J. Frandell, treasurer; Commander Woodson, National Council representative; and the following directors: Mr. Acker; G. E. Agnew, Daniel Dwyer, Capt. H. C. Maynard, Herbert M. Palmtag, C. A. Ragan, and G. Swanson.

New York Post Hears Tape Recordings Of Interviews With Korean War Prisoners

The New York Post held a special meeting on Tuesday, April 16th, at the University Club, New York City, with approximately 180 persons in attendance.

The meeting was convened by Lieut. Gen. Leslie R. Groves, Post president, who introduced the first guest speaker, Dr. Arthur L. Klein. Doctor Klein acted as narrator in connection with the presentation of a tape recording of actual interviews with returned American prisoners of war in Korea, together with analyses and conclusions.

This part of the program was designed to focus attention on the impact of psychological warfare on our national security and its direct influence on the intensity of our industrial preparedness program.

General Groves then introduced Col. John O. Weaver, Office of the Chief, Troop Information, Department of the Army. Colonel Weaver discussed the Troop Information Program and its accomplishments in the area of preparing our soldiers for such enemy treatment as "brainwashing" by keeping them informed. Colonel Weaver's discussion included the presentation, for inspection by the group, of various publications prepared and distributed by his office for troop consumption.

A buffet supper concluded this novel and thought-provoking meeting.

Bomb And Warhead Group Presents Technical Papers At Army Chemical Center

The Bomb and Warhead Assembly Section of the Bomb, Warhead and Artillery Ammunition Division met on Thursday and Friday, April 16th and 17th, under the chairmanship of Brig. Gen. Merle H. Davis, secretary of the Section, at the Army Chemical Center, Md.

Brig. Gen. Harold Walmsley, Chief of the Chemical Corps Matériel Command, Edgewood, Md., welcomed Section members. A major part of the day's session was devoted to the presentation of the following technical papers: "C/R Warhead Development for Zuni, Sidewinder, and Sparrow III," by Henry Wedaa, Rheem Manufacturing Company, Downey, Calif.; "The Aerojet AGX-3100 Warhead," by Don Kennedy, Aerojet-General Corporation, Azusa, Calif.; "The T39 (Honest John) Warhead," by C. J. Kobialka, Picatinny Arsenal, Dover, N. J.

Also, "Aimed Warhead," by Don C. Woods, Rheem Manufacturing Company, Downey, Calif.; "Development of the Mark 79, Model 1, Firebomb," by Robert E. Niederstrasser, Navy Bureau of Ordnance, Washington, D. C.; "Warhead Development and Testing," by Dr. Russell H. Lyddane, U. S. Naval Proving Ground, Dahlgren, Va.; "The Warheads for the Hawk Missile," by Mr. Kobialka, Picatinny Arsenal.

Also, "Possible Tactical Uses for Biological Warfare," by Lieut. Col. R. M. Clendenin, Fort Detrick, Md.; "Recent Concepts and Developments in Biological Warfare," by Donald A. Falconer, Fort Detrick, Md.; "Anticipated Production Requirements for Biological Warfare," by Everett E. Champlin. (*Contd. on p. 110*)

...NEWS IS HAPPENING AT NORTHROP

Demonstrating the platform of LINS – new, Lightweight Inertial Navigation System – is Dr. William F. Ballhaus, Vice President and General Manager of Nortronics.

NORTRONICS REVEALS LINS... COMPLETE PRECISION INERTIAL NAVIGATION SYSTEM!

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Actual working hardware, LINS is a complete, precision system for automatic navigation applications to advanced aircraft, drones, missiles, and space vehicles. It is ready now – the latest result of Nortronics' more than twelve years of creative research and production in the field of automatic guidance and navigation systems.

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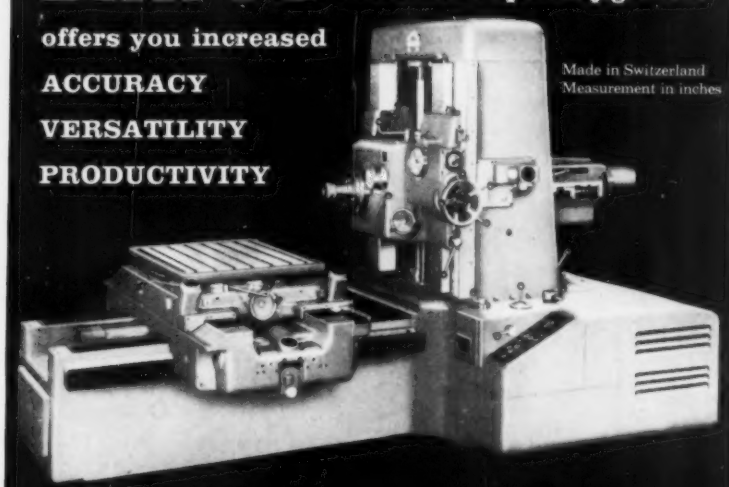

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Association Affairs (Contd.)

On the second day of the meeting, April 17th, presentations were made by members of the Chemical Warfare Board and by the staff of the Research Laboratories of the Chemical Corps.

The following subjects were outlined: "Organization and Mission," by Col. Donald E. Yanka; "Chemical Warfare Agent Research," by Dr. Edward Metcalf; "Chemical Warfare Munitions Development," by Dr. Bernard Berger; "Defensive Aspects of Chemical Warfare," by Gerald Fleming; "The Role of Chemical Warfare and Biological Warfare in Future Warfare," Col. Montescue T. Moree and Maj. James J. Zidar.

Following this technical session, the group visited the Medical Research Laboratory for an interesting and instructive toxicity demonstration.

Executive Board, Missiles And Astronautics Division, Discusses Future Meeting

The Executive Board of the Missiles and Astronautics Division met at the Sheraton-Carlton Hotel, Washington, D. C., on April 15th, under the chairmanship of C. L. Eksergian, Budd Company, Detroit, Mich.

An ad hoc committee headed by Carl E. Johnson, Lockheed Aircraft Corporation, Sunnyvale, Calif., decided that it would be of the greatest immediate interest to have the next Division meeting in Colorado Springs, Colo., under the auspices of the North American Air Defense Command.

A general session in the morning would be followed by more specific Section and Committee meetings in the afternoon. The following day would consist of a complete briefing from the commander of NORAD and members of his staff at their headquarters in Colorado Springs. The choice of dates will be during the latter part of October or early in November.

Columbia River Post Meets At Portland Air Force Base And Elects New Officers

The Columbia River Post's annual dinner meeting was held on April 23rd at the Portland Air Force Base Officers' Club, Portland, Oreg.

Edward A. Haas, retiring Post president, presided and delivered a report to the members on the Washington, D. C., meeting of all A.O.A. Post and Division officials. He then called for approval of the new slate of officers presented by the

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nominating committee and introduced his successor, Harry R. Matheson, Benson Polytechnic High School.

Toastmaster John R. Anderson, Post secretary, introduced the two guests of honor, Maj. Walter G. Jameson, commanding officer, Northwest Regional Office, San Francisco Ordnance District, Seattle, Wash., and Charles Davis, small-business specialist in the San Francisco Ordnance District.

Major Jameson reviewed current Army research and development in weapons systems for missiles in ground warfare and air defense. He then discussed the role of the Pacific Northwest in Army Ordnance contracting programs.

After the major's interesting talk he and Mr. Davis answered questions on specific procurement problems.

Reactivated Lansing Chapter Hears Panel Of Experts Discuss Guided Missiles

The reactivation dinner meeting of the Lansing Chapter of the Michigan Post brought a large crowd to the Oldsmobile Auditorium in Lansing, Mich., on Wednesday, April 29th. The highlight of the affair was a presentation entitled "The Guided Missile Program" by a team of missile experts from the Pentagon.

Leader of the panel was A. G. Waggoner, executive assistant to the Defense Department's Director of Guided Missiles. With him were Lieut. Col. William Teir, Assistant Chief, Missile and Space Division, Department of the Army; Col. E. A. Kiessling, Assistant for Missiles and Military Space, Air Research and Development Command; and Capt. Eugene Fairfax, assistant director, Guided Missiles Division, Office, Chief of Naval Operations.

Chapter Chairman Robert J. Cook, as presiding officer introduced Jack P. White, public relations director, Oldsmobile Division of General Motors Corporation, the toastmaster. Mr. White then introduced the head-table guests and the new Chapter officials present, and called on Mr. Waggoner to introduce his team.

The guide lines for the presentation were established by Mr. Waggoner who described the beginning of missile development in this country and noted that it was a committee headed by Dr. Von Neuman that urged increased emphasis on the intercontinental ballistic missile program. He made it clear that the three services must pursue their own missile development to meet their particular needs and that there was no unnecessary duplication.

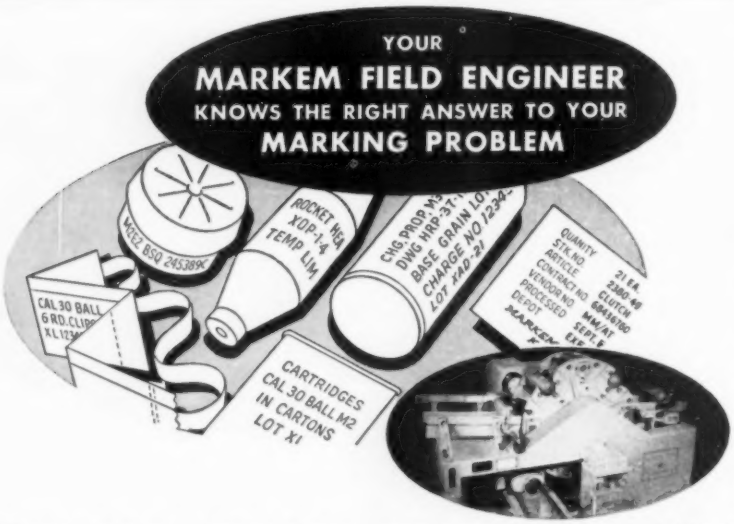
Colonel Tier showed some excellent films of Army missiles in action and described the tactical use of operational weapons, both those used for ground battle and air defense.

Captain Fairfax, in discussing Navy weapons, reported that the small Tartar antiaircraft missile would be as effective as the Terrier. He also predicted successful development of the new missiles—the air-to-air Eagle, the air-to-surface Corvus, and Subroc, for antisubmarine use.

Colonel Kiessling described the status of the Air Force family of missiles, including Bomarc, Hound Dog, White Lance, Quail, and the ICBM's. He then briefed the audience on the Air Force plans for their incentive type of contract which should reduce lead time and testing costs.

Others at the speakers' table were: Rev. Harold Jacobs, pastor, Potter Park Methodist Church; Maj. Gen. G. C. Moran, Adjutant General of Michigan; Mervyn G. Gaskin, president, Michigan Post; Capt. J. M. P. Wright, A.O.A. staff director for Post operations; and E. J. Duke, secretary-treasurer, Lansing Chapter, Michigan Post.

A special vote of thanks was accorded to Mr. Duke and his committee for their excellent arrangements for the meeting.



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Casting Section Members, Military Representatives, Meet In Washington, D. C.

Members of the Casting Section, Production Techniques Division, and Government representatives met in Washington, D. C., on May 21st. Section Chairman Stowell C. Wasson, National Malleable & Steel Castings Company, Cleveland, Ohio, conducted the meeting.

After Maj. Gen. August Schomburg, Deputy Chief of Ordnance, United States Army, Washington, D. C., welcomed the members, a film on the production of cast shell was shown.

The following technical papers covered various aspects of the foundry industry: "Range of Technical Capabilities of Today's Foundry Industry," J. Harry Jackson, Battelle Memorial Institute, Columbus, Ohio; "Capabilities of Segments of the U. S. Foundry Industry," John R. Worrilow, Lebanon Steel Foundry, Lebanon, Pa., and Mr. Wasson; "The Malleable Foundry Industry," Collins L. Carter, Albion Malleable Iron Company, Albion, Mich.; "The Gray Iron and Ductile Iron Foundry Industry," W. M. Dalton, Dalton Foundries, Inc., Warsaw,

Ind.; "The Precision Foundry Industry," Robert R. Miller, Precision Metalsmiths, Inc., Cleveland, Ohio; "The Light Metals Foundry Industry," H. C. Erskine, Aluminum Company of America, Pittsburgh, Pa.; "The Copper Base Foundry Industry," John F. Klement, Ampco Metals, Inc., Milwaukee, Wis.

Maj. Gen. Edward P. Mechling, A.O.A. staff director for technical operations, then introduced the military service representatives and led the group in an open discussion. Government personnel and non-Section members were guests of the Casting Section Steering Committee for dinner at the Army-Navy Club in Washington.

• **DEPUTY SECRETARY OF DEFENSE DONALD A. QUARLES**, a life member of the American Ordnance Association and an Association medalist, died at his home in Washington on Friday, May 8, 1959. His career as scientist, engineer, and administrator in commercial and governmental service was outstanding and contributed to a unique degree to the advancement of both.

Secretary Quarles was a native of Arkansas and a graduate of Yale where he majored in mathematics and physics. He served as a captain of Field Artillery in the Rainbow Division in Europe during World War I. Thereafter he began his long and successful career with the Western Electric Company where he specialized in research on transmission engineering.

During World War II he managed the transmission department of the company, being in direct charge of the Bell Telephone Laboratories' radar program. Later he was in charge of developments for both military and commercial purposes and became a vice-president of Bell Telephone Laboratories, Inc.

Prior to his governmental service he was an official of Western Electric Company and president of Sandia Corporation, the company's subsidiary which operates the Sandia Special Weapons Laboratory at Albuquerque, N. Mex. One of Mr. Quarles' first public appearances on the defense scene was at Detroit, Mich., in 1948 when he delivered a paper at the thirtieth annual meeting of the Ordnance Association on "Trends in Military Research."

Upon reorganization of the Department of Defense, Mr. Quarles left Sandia to become Assistant Secretary of Defense for Research and Engineering. After three years in this office he became Secretary of the Air Force and assumed his duties as Deputy Secretary of Defense in 1957. Secretary Quarles was awarded the Association's Williams Gold Medal in 1957 and delivered the address to the membership in that year at the Waldorf-Astoria, New York City.

A public servant of pronounced dedication, quiet and unassuming, he was an engineer of outstanding attainments. In the words of President Eisenhower: "As Deputy Secretary of Defense and prior to that as Secretary of the Air Force, Mr. Quarles devoted his extraordinary talents to the service of his country. His contribution was of inestimable value to the security, not only of the United States, but of that of the entire free world. I share with his associates in the Government a keen sense of personal loss."

So also do countless members of the Ordnance fraternity who had known and admired this talented gentleman over many years.

• **WHITLEY C. COLLINS**, president of the Northrop Corporation and a past president of the Association's Los Angeles Post, died in Los Angeles, Calif., on May 12, 1959. He had been president and chief executive officer of the company since May 1954 and was recently cited by the Legislature of California for his outstanding civic, cultural, and business contributions to the State and the Nation.

In addition to his responsibilities in directing the Northrop operations, Mr. Collins was a trustee of the California Institute of Technology and Claremont Men's College. In 1956 a dining hall on the campus of the latter institution was named in his honor. He also was board chairman of the Hollywood Bowl Association.

Mr. Collins took an especially active part in the activities of the Los Angeles Post and cooperated most generously with the other officers and members in the phenomenal growth of the Post in recent years. He was elected to the presidency of the Post in 1958 but was compelled to relinquish the office on account of failing health. He also was a member at large of Council of the national Association.

Mr. Collins will be missed greatly by his associates of the Post and throughout the Ordnance fraternity, particularly among the aircraft and missile contingents.

• **ROBERT A. UIHLEIN, SR.**, vice-president and secretary of the Joseph Schlitz Brewing Company, died in Milwaukee, May 13, 1959. He was a charter member and one of the organizers of the Association's Milwaukee Post. For many years he served as a member of the Post's board of directors.

Mr. Uihlein was graduated from Cornell University Law School in 1904, and after studying abroad returned to Milwaukee to direct the widespread operations of the Schlitz Company. Always active in matters connected with national and local advancement, he was a director of the First Wisconsin National Bank, First Wisconsin Trust Company, and the Wisconsin Bankshares Corporation. He also was a trustee of the Northwestern Mutual Life Insurance Company.

In addition to his philanthropic interests he was a hunter, yachtsman, and ornithologist. He financed and participated in expeditions to the Arctic and Alaska for the Milwaukee Museum. He also made canoe trips on the San Juan and Colorado Rivers to study bird life. Cognizant of the importance of industrial preparedness, he gave generously of his counsel to the Ordnance Association and assisted materially in its growth over the years.

• **NICHOLAS LAWRENCE ETTEN**, president of the Chamberlain Corporation, Waterloo, Iowa, died April 8, 1959. A brilliant and resourceful engineer, he made a host of contributions to ordnance development as well as to the appliance industry—as indicated in some small measure by the ninety-one patents granted him in his lifetime.

Generous to his friends and employees almost to a fault, and devoted unselfishly to the interests of his country, he left literally an army of mourning friends, both in the services and in industry.

For years he was chairman of the Bomb Committee of the Ordnance Association—now the Bomb and Warhead Section. His sound guidance will be missed by this group and by all his many friends in the Ordnance fraternity.

• **WILFORD J. HAWKINS**, a member of the American Ordnance Association for over twenty years, died in the Portland (Maine) Hospital on April 10, 1959. He was a retired mechanical engineer who held patents on ordnance equipment and industrial machinery.

Mr. Hawkins was vice-president and works manager of the International Arms and Fuze Company from 1915 to 1922 and executive vice-president of the American Machine & Foundry Company and subsidiaries from 1922 to 1932. He later was chief engineer of the National Biscuit Company and works manager of the Atlas Ansonia Company. He retired in 1949.

A graduate of the United States Military Academy in 1903, Mr. Hawkins served as an ordnance engineer in the Army until 1915, attaining the rank of major.

NEW DEVELOPMENTS

Our Modern Army

The Army recently revealed that it is experimenting with a tank using nylon armor instead of the conventional steel armor plate. Initial results indicate that the nylon will offer as much protection as steel with a great saving in weight.

It also was disclosed that Avro Aircraft, Ltd., of Canada has produced a "flying saucer" eighty feet in diameter for the Army. It is claimed that the new aircraft can attain a speed of 400 miles an hour and an altitude of more than 15,000 feet. It can carry 12 passengers. Further development will increase both the performance and payload.

Zeus Motor Fired

Static firing of a full-scale tactical sustainer motor for the Nike-Zeus antimissile missile was completed recently at Beaumont, Calif. The motor was developed by Grand Central Rocket Company of Redlands, Calif., for Douglas Aircraft Corporation, a major subcontractor on the Zeus program.

This recent accomplishment was achieved through an unusually efficient motor case with thin walls, special high-energy propellants, and a unique plastic nozzle developed by Douglas, which sustained thousands of degrees of heat with perfect results.

The booster for the Nike-Zeus missile was static-fired for the first time last year at Redstone Arsenal. Developed by Thiokol Chemical Corporation, the booster produces several hundred thousand pounds of thrust and is capable of hurling a defense missile to extreme altitudes almost instantaneously.

Navy Bullpup Missile

The U. S. Navy's air-to-surface guided missile Bullpup became operational recently when the U.S.S. LEXINGTON (CVA-16) sailed from Alameda, Calif., for the Western Pacific. Aboard the LEXINGTON is Attack Squadron 212, the first Navy unit to take the Bullpup into an operational assignment. Also in the carrier's arsenal is the air-to-air guided missile Sidewinder which has been operational for more than two years.

The Bullpup is the first guided missile which requires no checking from factory to firing. It can be loaded into a plane as easily and quickly as a bomb or rocket and uses normal shipboard stowage and handling equipment. It weighs about 540 pounds, including a 250-pound nonnuclear warhead, is about 11 feet long, and a foot in diameter. It was designed by the Martin Company, which manufactures the missile in its Orlando, Fla., plant. Martin has a $20.4 million Navy contract for Bullpup production.

The supersonic Bullpup is power-driven by a solid-propellant rocket motor designed by the Naval Propellant Plant, Indian Head, Md., and is guided by command control from its launching plane through a self-contained navigational system.

Bullpup carries two flares which enable the pilot to keep it in line of sight, under command control, until it impacts. It is a relatively inexpensive and highly accurate nonnuclear missile and can be used in close air support against comparatively small targets such as pillboxes, tanks, truck convoys, bridges, and railway tracks.

Bullpup is the sixth guided missile in active service with the U.S. Fleet today. The others, in addition to Sidewinder, are the air-to-air Sparrow III, the surface-to-air Terrier and Talos, and the surface-to-surface Regulus I.

Shillelagh Missile

The Shillelagh, a new lightweight surface-to-surface guided missile system for close-in support of troops, is about ready for full-scale development. The Shillelagh greatly increases firepower against armor as well as troops and field fortifications. It is expected to be operational in the mid-1960's. Vehicle mounting is one application of this system.

Contractor on the missile system is Aeronutronics Systems, Inc., of Glendale, Calif., a subsidiary of Ford Motor Company. The Army will spend approximately $3,000,000 on the project in fiscal 1959, but the contract eventually is expected to run to about $23,000,000.

The Ordnance Tank-Automotive Command, Detroit, Mich., is responsible for development of the Shillelagh, and the Army Rocket and Guided Missile Agency, Redstone Arsenal, Ala., is the contract supervisor.

Tropospheric Wireless

Contracts totaling more than $6 million for equipment for "Ace High," Western Europe's first fully integrated long-distance wireless communications system, have been awarded by SHAPE (Supreme Headquarters, Allied Powers in Europe) to the Dynamics Corporation of America, subsidiary of Radio Engineering Laboratories, Inc.

The contract calls for the company to build some 360 units for installation at 41 stations in 9 countries, to link NATO's defenses into a 6,500-mile trans-European chain stretching from Turkey to Norway and Great Britain, and making "Ace High" the longest "tropo-scatter" system in the world.

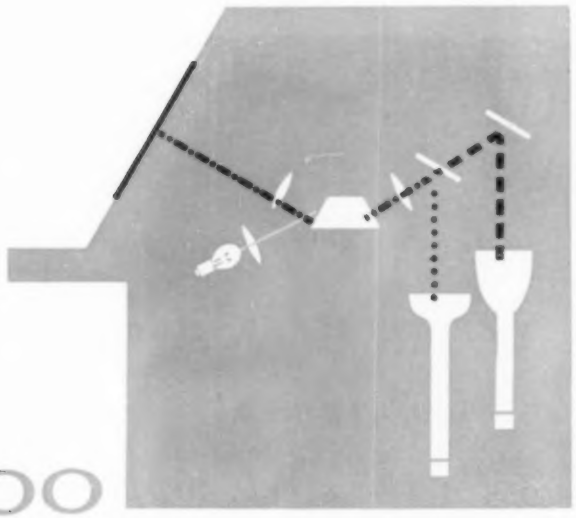
In combination with other "tropo-scatter" systems already operating and planned from the Aleutians to Iceland, "Ace High" will give the Western powers an unbroken line of wireless communication systems stretching more than halfway around the world—from the western to the eastern borders of Russia—running all the way from Turkey northward to Norway and the Faeroes Islands, westward via a new BMEWS system to Labrador, then across Northern Canada and Alaska to the Aleutian Islands.

Because tropospheric scatter communication is static-free and virtually impervious to interference, it transmits voice messages with a quality equal to wired systems and operates with complete dependability under weather and ground conditions that render other forms of transmission unreliable or impossible. It "bounces" ultra-high-frequency FM radio signals off the troposphere, relaying messages in over-the-horizon "leaps" of as much as 250 miles.

Electronic Ordnance Control

The Navy now is using a new electronic data processing system to keep track of its missiles and ammunition throughout the world. The method, devised by the Bureau of Ordnance, is an all-transistor, high-speed, data-processing system developed by the Radio Corporation of America.

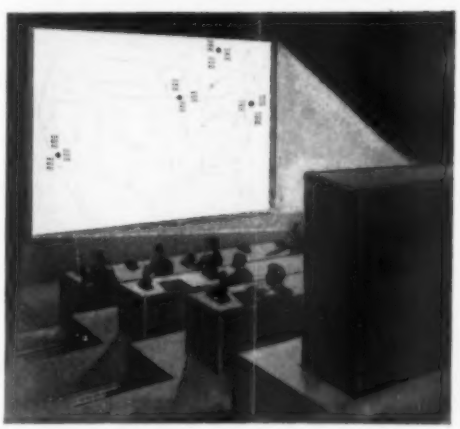
As the initial step in a 5-phase logistics program, the system is expected to provide high-speed inventory control of missiles, mines, torpedoes, bombs, and bullets from the time they start through the production line until they are expended in actual use. *(Contd. on p. 116)*



S-C 2000

BRIGHT DISPLAYS FOR CONSOLE OR LARGE SCREEN PROJECTION

Bright, fail-safe, flicker-free display of alpha-numeric, symbolic and graphic data at high speed . . . simultaneously with PPI-type radar presentations . . . is now provided by S-C 2000 Bright Displays. Displayed data may be viewed in normal ambient light directly on the screen of the S-C 2000 console, or may be projected for group viewing on a large theatre-type screen. For air traffic control and military applications, maps may be displayed concurrently with radar targets and their identifying symbols, assisting the operator in geographic orientation. The fail-safe feature of S-C 2000 Bright Displays results from use of the xerographic process which allows the last frame displayed to be retained permanently, even in event of complete power failure. Send for more complete information concerning S-C 2000 Bright Displays. Ask for Bulletin 6-O. Write today: Stromberg-Carlson — San Diego, 1895 Hancock Street, San Diego 12, California.



See the S-C 2000 Bright Display demonstrator at the AFCEA Show, June 3-5, Washington, D.C.—Booth 89.

GENERAL DYNAMICS
STROMBERG-CARLSON DIVISION

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engineers, builders

of equipment

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brass, aluminum,

rubber, plastic and

chemical industries

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CONTINUOUS GALVANIZING LINES • CONTINUOUS ANNEALING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES • SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER AND PLASTIC

Eventually, the system will be employed for over-all logistics control on nonexpendable items—such as guns, gun mounts, and missile launchers—as well as for financial management, quality evaluation, and research project management.

New Test Track

A new captive missile test track 35,000 feet long—the largest and longest in the world—recently was put into permanent laboratory use at the Air Force Missile Development Center, Holloman Air Force Base, N. Mex. Developed and built at a total cost of $12 million, the gigantic outdoor laboratory will be used to simulate actual flight conditions for missiles and missile components.

The track is an extension of the original 3,500 feet of track

High-speed test sled hits water brake.

which was used for Col. John Paul Stapp's famed 632 m.p.h. ride and his near-instant water-brake stop in 1 2/5 seconds in December 1954. On the new enlarged track, entire weapon systems or individual components can be loaded aboard rocket sleds and fired down the twin rails at supersonic speeds. In this manner the actual pressures of launch, flight, and deceleration can be imposed on the missile with one great advantage—at the other end of the track scientists can recover the missile in perfect condition and find out what happened to it during its "flight."

The general areas to be investigated on the 35,000-foot track include: (1) Impact tests of warheads for several different types of missiles; (2) Testing of various types of missiles; (3) "Debugging" of missiles and missile components, especially important in antimissile development; (4) Testing of missiles under acceleration, deceleration, impact of hail, snow, dust, rain, and wind gusts at high velocity and under cross-wind conditions; (5) Flutter testing of airfoil sections; (6) Human tolerance to windblast and G-load studies.

Water provides the braking power for controlled deceleration of the test sleds. Sections of the center trough between the rails are filled with water and maintained at various levels by dams placed at 10- and 20-foot intervals. A scoop, mounted beneath the sled, picks up the water from this trough and throws it out from the sides of the sled, thus slowing it to a stop almost instantaneously.

Air Weapons Control

A universal air weapons control system made up of radar, communications, and data-processing equipment is being developed as the U. S. Air Force's answer to the vast problem of air defense outside the continental United States.

Designated the Air Weapons Control System 212L, the new system will be capable of controlling a wide variety of weapons and systems and will be designed for both fixed and mobile

...NEWS IS HAPPENING AT NORTHROP

Now being produced and delivered to the U.S. Army Signal Corps, the Radioplane SD-1 gives greater battlefield surveillance flexibility to combat units than ever before. (This photo of terrain was actually taken from an SD-1 at 1,000 feet.)

RADIOPLANE PRODUCES FIRST COMBAT-READY SURVEILLANCE DRONE

Meeting tough Army Signal Corps requirements and being produced in operational quantities, the SD-1 is proved and ready to fly unmanned photo reconnaissance missions for tactical troops.

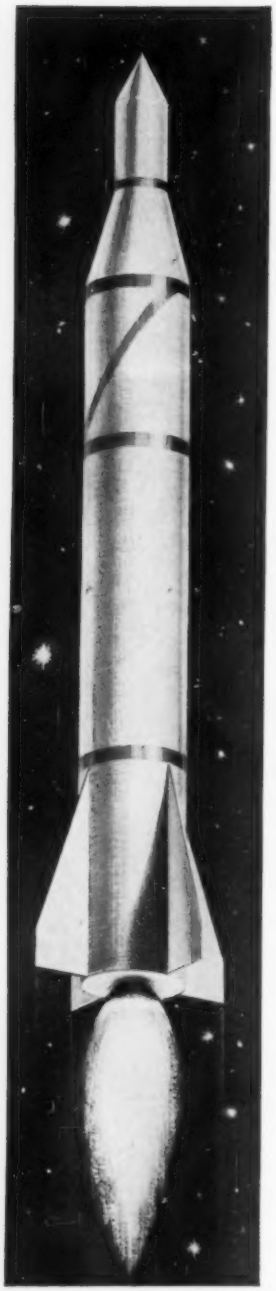
Highly mobile, the camera-carrying SD-1 may be zero-length launched in rough terrain from a camouflaged position. It is flown by remote control over enemy installations on surveillance missions without risking a pilot's life or man-carrying aircraft. Within minutes after the SD-1 returns from its mission, photographs are delivered to the requesting unit.

Other specialized sensory equipment may be carried by the SD-1 depending on particular mission requirements.

This Army-Radioplane achievement exemplifies Radioplane teamwork with all of the U.S. Armed Forces. Radioplane provides a complete drone family spanning medium speeds through supersonic performances.

RADIOPLANE

Van Nuys, California, and El Paso, Texas
A Division of
NORTHROP CORPORATION



GEAR ACCURACIES IN SECONDS TO GOVERN MILLION MILE FLIGHTS

When Gears of almost unbelievable accuracy are required for America's newest giant missiles designers naturally call upon Equitable Engineering. The nation's leading industries have learned to depend upon Equitable to meet their toughest problems wherever the finest, most exquisite perfection is called for in gears.

Typical of Equitable's everyday production:

- Gears rolling together within 50 millionths of an inch total composite error, as determined by electronic checking equipment.
- Design and production of complete, high precision gear trains guaranteeing input to output accuracies *in seconds*.
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Member: American Gear Manufacturers' Association

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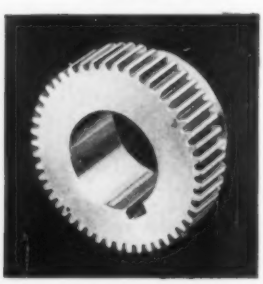


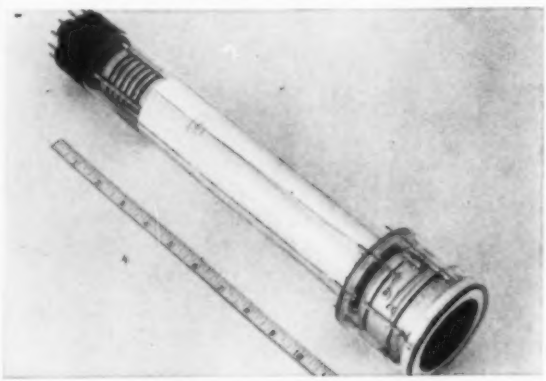
Equitable's new 16-page catalog . . . just clip this coupon to your letterhead.

New Developments (Contd.)

applications. It will be used primarily outside the United States since the SAGE (semiautomatic ground environment) system is used for defense of this country.

"Seeing Eye" Tube

The nuclear submarine SKATE was able to operate and surface almost at will in the Arctic Ocean on its recent winter voyage to the North Pole with the aid of a supersensitive television camera tube developed by General Electric Company. Even though during the Arctic winter very little sunlight reaches the area above the ice, and almost none at all below



Low-light-level image orthicon tube.

it, the sensitive tube was able to spot faint patches of light on the dark ice which indicated ice lakes where the SKATE could surface safely.

The SKATE's television equipment consisted of the new tube—known as a low-light-level image orthicon—in a special compact camera developed by the Friez Instrument Division of Bendix Aviation Corporation, which transmitted pictures to receivers inside the submarine. The camera was mounted in a shockproof enclosure on the vessel's forward deck.

The system has been under development for the Navy and the Army's night-vision and fire-control program. Since the Navy unit was not due for completion in time for the SKATE's voyage, the Army unit was modified and loaned to the Navy for the polar probe.

The Department of Defense has reported the television system "has capabilities for night viewing far beyond any previously achieved."

The new tube is so sensitive to light that it can literally "see in the dark" and can produce intelligible, bright pictures on a television receiver of objects in areas too dark for the human eye to see anything. The tube does not require any special artificial light, such as infrared, to perform its work.

Flying Belt

Aerojet-General Corporation is developing a compact rocket-powered unit, known as Aeropak, that may propel special rocket troops of the future and enable a man to fly up, down, across, or hover in mid air. A demonstration model of this device is now under contruction by Aerojet's Systems Division and is expected to be ready this fall.

The device will enable special troops to zip across mine fields, ravines, and rivers; zoom up cliffs, trees, and buildings; and reach otherwise inaccessible locations. Rescue operations from cliffs, fires, drownings, etc., also could be performed. The unit is a lightweight, rigid metal device strapped to the back of its operator with a rocket nozzle near each shoulder of the flier. Control of the two rockets is performed manually. The operator regulates his direction with a lever in his left hand and throttles his speed with a valve in his right.

This concept of man's attempt to harness bird power in an attempt to fly first appeared in "The Man in the Moon"—published in Paris in 1648. In 1659, the same mode of air travel was depicted in another book, "The Flying Wanderer" Here, Brussel-Smith, noted graphic artist, has interpreted the original drawing through the medium of wood engraving.

IMAGINATION IN SPACE

Since Creation, man has looked out on space. At first, unknowing and incurious; then with the beginnings of understanding; now free and able to explore. Yet to move in space calls for wholly new concepts of energy.

This, then, is the working philosophy of Hercules in chemical propulsion: To design and manufacture highly concentrated packages of energy as propellants and rocket motors; each compatible, controllable, predictable; and each perfected for its specific mission.

HERCULES' BACKGROUND: A half-century of creative imagination in the evolution of propellants, from shotgun powder to space propulsion; encompassing research, design, engineering, and staff organization —for the production of the most advanced propellants.

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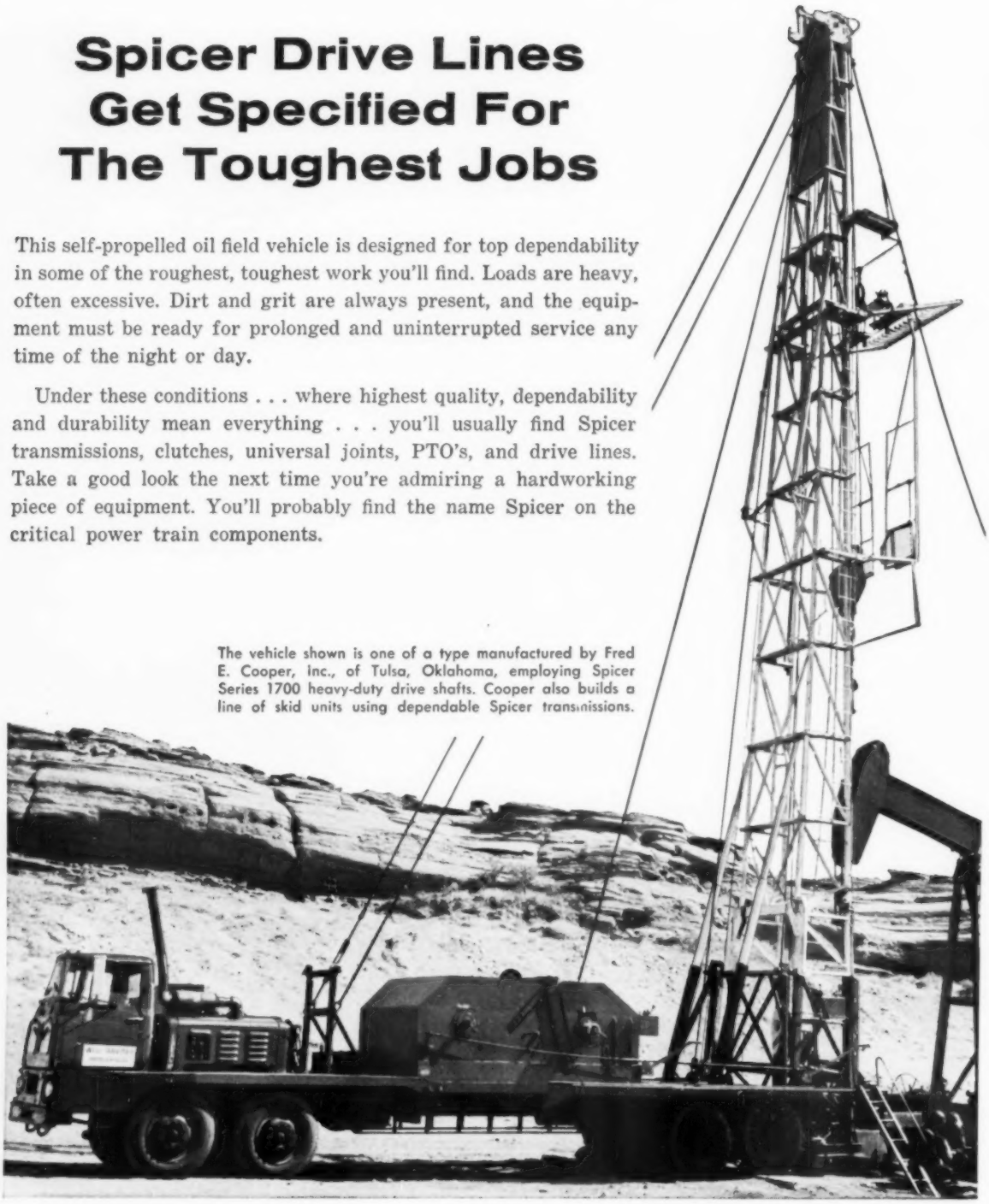
XP59-2

Spicer Drive Lines Get Specified For The Toughest Jobs

This self-propelled oil field vehicle is designed for top dependability in some of the roughest, toughest work you'll find. Loads are heavy, often excessive. Dirt and grit are always present, and the equipment must be ready for prolonged and uninterrupted service any time of the night or day.

Under these conditions . . . where highest quality, dependability and durability mean everything . . . you'll usually find Spicer transmissions, clutches, universal joints, PTO's, and drive lines. Take a good look the next time you're admiring a hardworking piece of equipment. You'll probably find the name Spicer on the critical power train components.

The vehicle shown is one of a type manufactured by Fred E. Cooper, Inc., of Tulsa, Oklahoma, employing Spicer Series 1700 heavy-duty drive shafts. Cooper also builds a line of skid units using dependable Spicer transmissions.



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DANA PRODUCTS Serve Many Fields:

AUTOMOTIVE: Transmissions, Universal Joints, Propeller Shafts, Axles, Powr-Lok Differentials, Torque Converters, Gear Boxes, Power Take-Offs, Power Take-Off Joints, Clutches, Frames, Forgings, Stampings.

INDUSTRIAL VEHICLES AND EQUIPMENT: Transmissions, Universal Joints, Propeller Shafts, Axles, Gear Boxes, Clutches, Forgings, Stampings.

AVIATION: Universal Joints, Propeller Shafts, Axles, Gears, Forgings, Stampings.

RAILROAD: Transmissions, Universal Joints, Propeller Shafts, Generator Drives, Rail Car Drives, Pressed Steel Parts, Traction Motor Drives, Forgings, Stampings.

AGRICULTURE: Universal Joints, Propeller Shafts, Axles, Power Take-Offs, Power Take-Off Joints, Clutches, Forgings, Stampings.

MARINE: Universal Joints, Propeller Shafts, Gear Boxes, Forgings, Stampings.

Many of these products manufactured in Canada by Hayes Steel Products Limited, Merritton, Ontario.

WASP

THESE MEN DO ALMOST NOTHING BUT THINK

Unique new group helps Westinghouse anticipate and plan for future military needs

It's harder than ever to stay out front in defense.

Weapons systems are now fantastically complex. New innovations—like thermoelectricity and molecular electronics—threaten to make key subsystems obsolete overnight. New developments may suddenly reduce the tactical usefulness of a U. S. weapons system.

Westinghouse, like many other firms, has been concerned about how to meet this problem—and how to organize its many R&D and manufacturing operations to more effectively support America's increasingly complex defense needs. It seemed that the organization which had worked fine in the past simply wasn't adequate for anticipated future demands.

So things were completely reorganized in February, 1958. A new Defense Products Group was established, centralizing control of all defense-oriented activities within the company.

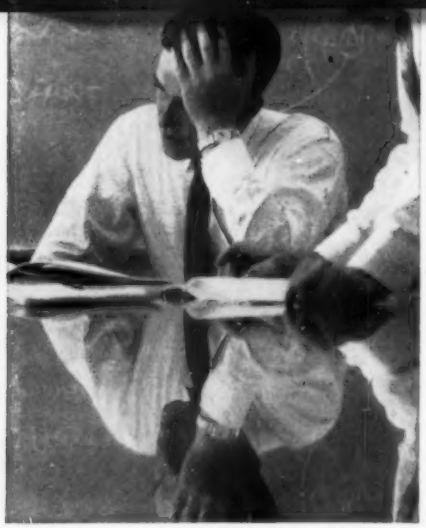
But a most interesting—and promising—part of this new organization, the new Westinghouse Advanced Systems Planning Group (now commonly called WASP), wasn't announced publicly until August.

This was a significant development. Since technology is moving faster than ever before, there's a real need to effectively anticipate what will be needed in 5 or 10 years. If this can be done, longer-lived defense systems can be developed more quickly and substantial sums can be saved. WASP should be able to provide the advance thinking needed by Westinghouse to meet this need.

Staffed with hand-picked engineers and scientists—specialists in electronics, outer space, atomic power, ASW, operations research, etc.—and headed by Allan Chilton (top center photo above), WASP operates on a unique charter: to concern itself primarily with

CONTINUED

WASP CONTINUED



"The idea is sound, but how can we keep it from burning up? Present insulations won't work. How about ablative heat sinks? No—they won't work either in this case."

complete advanced weapons systems, to deal with the "whole" instead of "parts".

This is not just a "blue-sky thinking" assignment. Westinghouse believes future defense needs will be so complex that only a full-time team of specialists—like WASP—will be capable of the kind of conceptual planning and guidance needed.

There's another reason why defense planners will be interested in WASP. This new group gives them a single point of contact within one of America's largest and most versatile industrial firms to which they can take immediate and long-range defense problems. No longer will it be necessary for someone

MATCHING NAVAL REQUIREMENTS with Westinghouse capabilities, Leonard Dow, a professional career specialist in naval strategy, tactics, and weapons systems, is associating advanced technology to future naval systems.

"... son, it circles the earth at 18,000 miles an hour." Space consultant, K. Satyendra, a Ph.D. from India, keeps WASP and other company scientists abreast of space needs. He is an authority in mission, trajectory, and communication concepts.

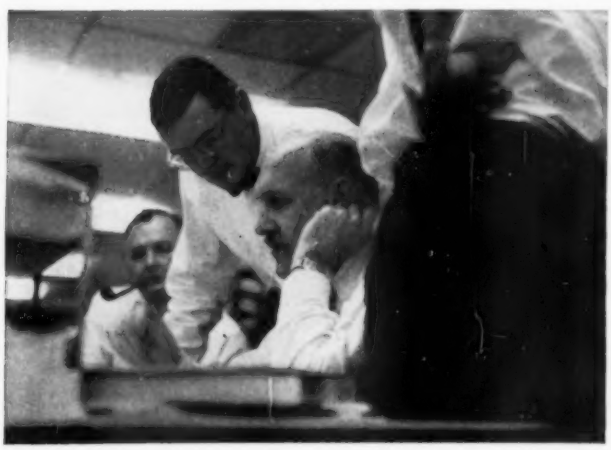
TOP ENGINEER AT WASP, Rein Kroon joined Westinghouse in 1931. Among other accomplishments, he headed the engineering group responsible for the design of the first American turbojet engine for aircraft.

"What's the best way to destroy an enemy reconnaissance satellite? Attack it from earth? Or from another satellite? How would we go about either method?"

to try to guess which Westinghouse division is best equipped to tackle a given job.

This is a bigger advantage than might be apparent. A newly-published capabilities chart*, for example, lists 29 different Westinghouse facilities and, for each, indicates specific study, design, or manufacturing capabilities in 33 different areas (infra-red, rocket powerplants, torpedoes, missile base equipment, etc.). This same chart lists 16 Westinghouse facilities which can handle system analysis and 7 capable of complete system management.

**Available to qualified individuals and firms upon request.*



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MATERIALS PROGRESS

George S. Brady

Rubber—Natural and Synthetic.—Rubber industry researchers, enthusiastic about the possibilities of the new isoprene rubber and the improved synthetic rubbers, are now saying that the United States can soon consider itself completely free from dependence on foreign sources of natural rubber. The *U. S. Rubber Company* is now in production on truck tires made from polyisoprene, the "synthetic natural rubber," and other companies will soon be using this type of rubber.

Heavy truck tires, and also high-grade white-wall passenger-car tires, have been employing the highest grades of plantation rubber largely because it generates less heat than synthetic rubbers. But polyisoprene is a close duplicate of natural rubber and, because it is made under closely controlled manufacturing processes, it has the advantage of greater purity and is thus more uniform in quality than natural rubber. Also, it does not require as much plasticizing.

The isoprene rubber being used by the U. S. Rubber Company comes from the *Shell Chemical Corporation* plant. The 750-20 truck tire has contained 17.8 pounds of natural rubber and 8.1 pounds of styrene-butadiene synthetic rubber. The new isoprene rubber is replacing the natural rubber. It is also planned to use isoprene in large tires for earth-moving equipment where the highest grades of natural rubber have been employed.

The Rubber Research Institute at Kuala Lumpur has been alert to the new competition and this year will bring out two new grades of SP (superior-processed) natural rubber. Whether the processed natural rubber can compete will depend greatly on keeping the price down. Even with the present relatively small production, isoprene rubber appears to be able to meet the price of regular grades of natural rubber.

So far, the sales balance of the rubber producers of Malaya has been preserved by shipments to the Communist countries—about 13,000 tons a month being sold behind the Iron Curtain. This amount, plus an even larger quantity from other producers, may indicate that the Soviet bloc is not yet abreast in the development of synthetics and that surplus supply troubles lie ahead when they catch up.

Possible liquidation of the present large American stockpile of natural rubber, now considered by many as unnecessary, constitutes another worry for the natural-rubber producers. Whatever the outcome, the introduction of isoprene rubber will have the effect of preventing any abnormal rise in the price of natural rubber.

Graphitic Carbon Fibers.—Two companies recently have commercialized two different processes for producing strong, fine graphitic carbon fibers suitable for high-temperature insulation and for heat-resistant fabrics. The *National Carbon Company* now has developed a process by which yarns, felts, or fabrics of rayon or other organic fiber are converted into graphitic carbon. The fabric is carbonized by heat and then graphitized at a higher heat of about 5,400 degrees Fahrenheit. The graphite fabrics thus made have tensile strengths up to 15,000 pounds per square inch. They are 99.9 per cent pure graphite and can be used as filters for hot chemicals, for flame arrestors, reinforcement for plastics, conveyor belting, and for high-temperature gaskets and packing.

All-Aluminum Auto.—*Kaiser Aluminum & Chemical Sales, Inc.*, has submitted to the automobile industry a design for an all-aluminum passenger car. Except for the glass and functional parts, aluminum has been used from bumper to bumper, including frame, engine, radiator, and die-cast wheels. The body panels are stamped sheet, and the doors are 2-piece die castings. It is not expected that an aluminum design will be adopted all at once by the industry, but the average per-car use of aluminum has quadrupled in the past decade and will increase further.

Reynolds Metals Company engineers also are design-conscious in forwarding aluminum usage and are offering departures from conventional designs long employed for other metals. The company is now producing heavy-end aluminum pipe with a light pipe body and with increased thickness and strength at the ends where the welded or threaded joints are made. The savings in metal and weight are as much as 27 per cent.

Aluminum in Electrical Coils.—Reynolds is looking for big increases in the use of aluminum in the electrical industry. Aluminum strip windings, insulated with anodized films or with resins, or interleaved with Mylar insulation, offer great savings in space and weight in electrical coils compared with conventional copper-wire coils. They also give better heat dissipation and permit higher current densities.

Conductivity of aluminum strip is only 61 per cent I.A.C.S. compared with 97 per cent for copper wire, but, based on equal current-carrying capacity, a pound of aluminum strip can replace two pounds of copper magnet wire. Strips are as wide as the coil, and the insulation needs only to withstand the turn-to-turn voltage and can thus be less than for the wire.

Scandium.—The Air Matériel Command has entered into a contract with the *Union Carbide Metals Company* for the production of one pound of 99 per cent pure scandium and for a detailed study of the physical and chemical properties of the metal. This is one of the ways in which military expenditures have been benefiting scientific progress by undertaking projects that normally might not be carried out for many years.

Scandium has never been produced in commercial quantities, and little is yet known about its properties. It has about the same density as aluminum, but its melting point of about 1,550 degrees centigrade is 2.5 times higher than that of aluminum. Much also needs to be learned about possible sources, since only small deposits of ores containing scandium are known at present.

Irradiated Plastics.—For altering the surface of the waxy fluorocarbon polymers so that they will take dyes and can be bonded, *Radiation Applications, Inc.*, Long Island City, N. Y., is subjecting the plastics to radiation from cobalt 60. The radiation modifies the surface of the plastic to give it good adhesion without decreasing the toughness and chemical resistance of the plastic part.

New Titanium Alloy.—*Union Carbide Metals Company* has developed a titanium which gives resistance to hot reducing acids such as hydrochloric acid without lessening the ability of the metal to resist nitric acid and other oxidizing agents. The alloy consists of titanium with the addition of 0.1 per cent of palladium. It was found that platinum, iridium, and

Colonel Brady is a consulting engineer, author, and editor, Washington, D. C. He is a well-known authority in the field of materials, and his "Materials Handbook" is a recognized source of information on the subject.

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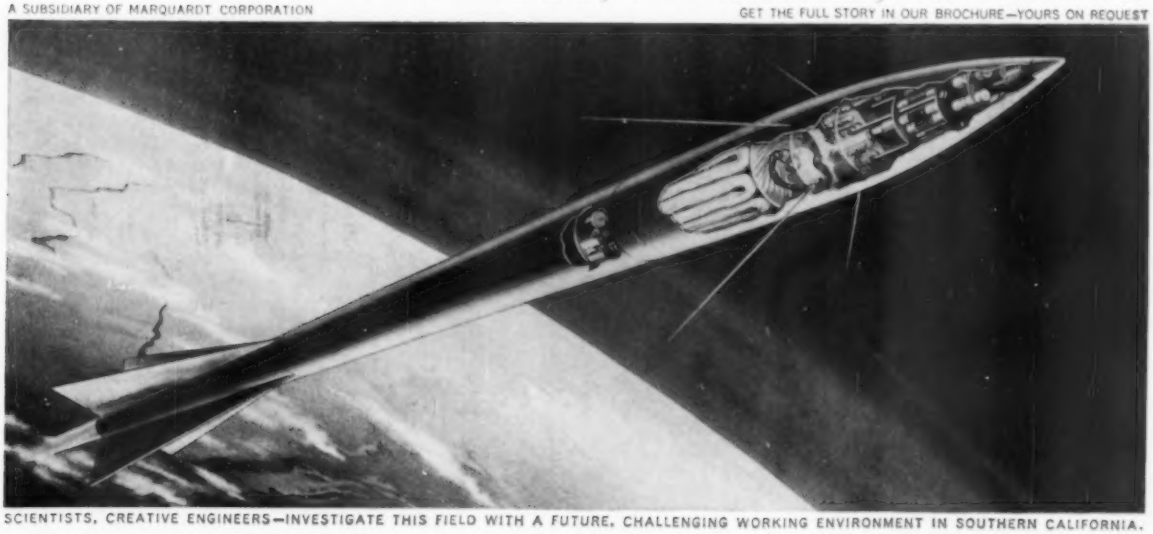

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Materials Progress (Contd.)

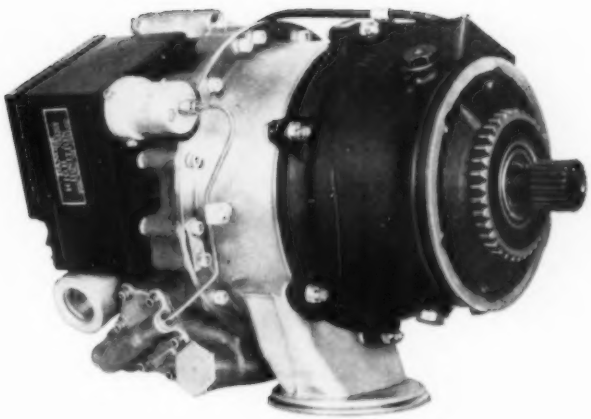
other noble metals also will impart electrochemical passivity to titanium, but palladium was selected since it is the lowest in price. This amount of palladium adds only about 28 cents per pound to the cost of the metal, but will add long life for such uses as pump and chemical equipment parts.

Explosive Metal Forming.—High-energy metal forming, although still in an early experimental stage, shows promise of large economies in the forming of large shapes that otherwise would require expensive machines, and also for the formation of tough metals such as are used for missile parts. *Boeing Airplane Company* has used the method to produce fuel tanks. *Ryan Aeronautical Company* has found that large savings can be made with the method in forming complex shapes with tough metals that work-harden and spring back in ordinary dies.

Two distinct methods have been employed to utilize the high pressure of explosives. In one, the partly formed part is inserted in the die and filled with water. The explosive is inserted in the water, and the blast molds the metal against the die. With the piston method, a pressurized gas is the medium to force the piston which strikes the work piece. Pressures obtainable are large compared with ordinary mechanical press pressures, being as high as 1,200,000 pounds per square inch for nitroglycerin and 690,000 pounds per square inch for TNT. Engineers working on the new process caution that it must be done under carefully controlled conditions to avoid injury to equipment and personnel.

Silicon Carbide Developments.—Although silicon carbide has been known and used for nearly three quarters of a century, completely new avenues of usage for this superhard material are resulting from recent laboratory work on large, high-purity, grown crystals. For abrasive purposes, where most of the material has been used, silicon carbide is well adapted for grinding very hard, nonductile materials because of its high hardness and high attrition resistance, but it also is suitable for materials of low grinding resistance which load and dull other softer grinding wheels.

The newer degrees of uniform high purity are essential for best results in this field, but the characteristics of very high dissociation temperature, high heat conductivity, and semiconductor possibilities are the factors that have opened up completely new fields of usage. Silicon-carbide nozzles can withstand the tremendous blasts from rockets, and silicon carbide thermocouples give a high millivolt output at temperatures to 2,200 degrees centigrade. The *Carborundum Company* has



The FAS 500-1 fuel-air jet engine starter makes Convair's F-106 fighter-interceptor ready for emergency scrambles. In as little as 12 seconds, this 48-pound, 165 hp. unit can bring the mighty J-75 engine compressor to 2500 RPM for starting, and sustain 3000 RPM several seconds more for acceleration and safety.

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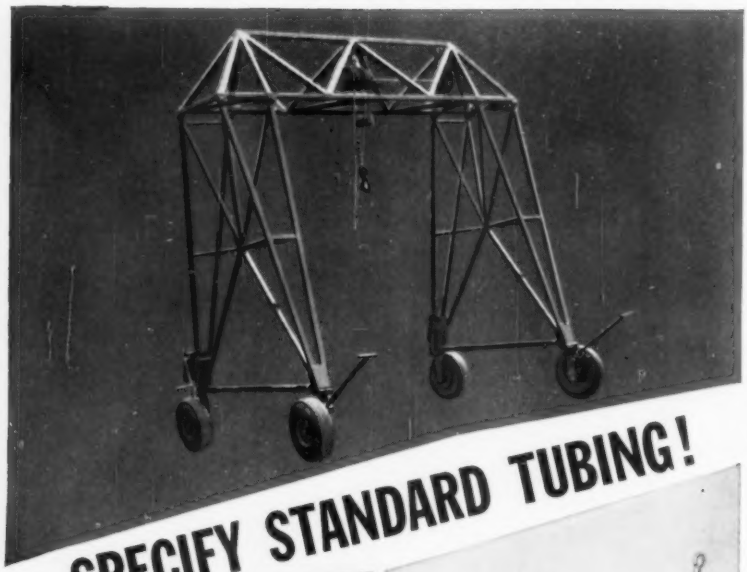

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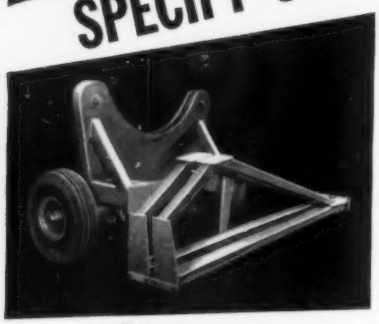

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Materials Progress (Contd.)

developed a lightweight silicon-carbide foam for rockets.

The growing of large, clear, high-purity crystals is now fairly well established. *Westinghouse Electric Corporation* has produced efficient silicon-carbide rectifiers that will operate at red heat, and other companies have shown the possibilities for very-high-temperature transistors.

Nylon Finishing Wheel.—A new finishing wheel material that gives a fine polish to metals and eliminates the need for buffing and polishing compounds is the Scotch-Brite of the *Minnesota Mining & Manufacturing Company*, St. Paul, Minn. It consists of disks of nylon web impregnated with fine abrasive grains. The disks are about a quarter-inch thick and can be ganged on a spindle to any width.

Plastic-Steel Screw.—A plastic screw produced by the *Austin Screw Products Company*, Chicago, Ill., is made of nylon with a serrated steel core which carries the torque and eliminates the danger of distorting or breaking of the plastic. The nylon comes in a range of colors for coding or for decoration.

Better Surface Finish.—*La Salle Steel Company* has been demonstrating that improvement in the physical qualities and in the surface finish of steels can be had by a modification of cold-drawing to draw at elevated temperatures up to as high as 1,200 degrees Fahrenheit. Carbon steels thus produced have uniformly high strength, and the parts do not require heat treatment.

High-Strength Alloys.—Research continues for steels that will maintain high strength and oxidation resistance at high temperatures, but most of the new types, which are complex alloys rather than steels, have a high nickel content. There are differences of opinion as to the availability of nickel in case of an emergency. Nickel production capacity in the free world is stated to be 550 million pounds this year, but increases in prospect may bring capacity to 650 million pounds within the next two years. Nickel actually is a more plentiful metal in nature than copper, the difficulties being in extraction and in the location of workable ores. In general, the supply situation is favorable.

Allegheny Ludlum Steel Corporation has a new alloy with a tensile strength of about 200,000 pounds per square inch that retains a strength above 125,000 pounds per square inch at 1,300 degrees Fahrenheit. It is a precipitation-hardening alloy containing 45 per cent nickel, 15 chromium, 4 molybdenum, 4 tungsten, 3 titanium, 1 aluminum, 0.30 each of manganese and silicon, a small amount of boron, and 0.05 carbon.

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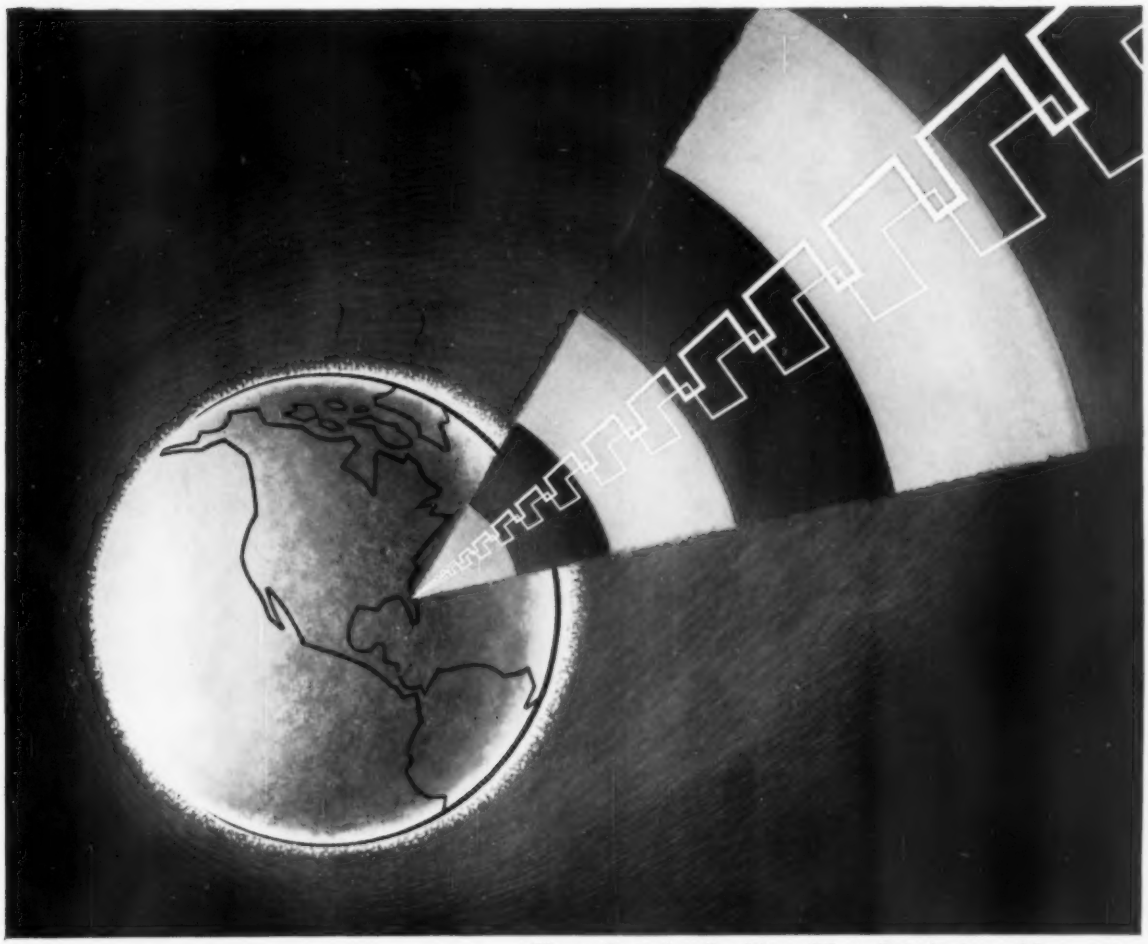

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ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Astronautics.—Perhaps the most controversial space experiment that the U.S. has yet performed in this astronautical age is Project Argus. Details of the tests made back in August and September of 1958 have only recently been made known. Small nuclear bombs were detonated at high altitudes (300 miles).

The resulting radiation movement was then monitored by high-altitude rocket soundings and by satellite passes through the band of radiation. The radiations induced by the bomb burst tended to follow the natural belt of earth radiation. It is speculated that, by a suitable device, the radiation could be made strong enough to interfere with various earth communications and even threaten long-range radar.

Present proposed applications include causing radio and radar blackouts over enemy nations and neutralizing or detonating incoming ICBM nuclear warheads.

Despite the natural radiation belt and the possibility of creating new synthetic bands or clouds, the United States has decided to forge ahead into space. The Advanced Research Projects Agency is asking for bids on several communications satellites. Project Courier, slated for launching in 12 to 18 months, is to consist of a 500-pound relay satellite. Twenty teletype messages (at about one hundred words a minute) could be transmitted between two earth stations.

Three repeaters, hovering in a 22,400-mile stationary equatorial orbit, would have the ability to handle several thousand teletype channels or 144 voice channels. Each satellite would weigh 600 pounds, and 3 could give worldwide coverage. Plans are to have such a military communications net in operation in about three years. This latter satellite project would be supplemented by a set of polar repeaters (each weighing 450 pounds) in operation at about the same time.

NASA has outlined its space programs, and, by the end of 1960, six space probes and fourteen satellites will be launched. A Venus probe, slated for this summer, has been shelved at least until next year, or more probably until 1962. Project Mercury, the manned satellite, is taking shape, and seven men have been selected for preliminary space flights.

Some twenty-six rocket firings are planned for the early stages of the program, and six "Little Joe" capsule tests are planned for launchings at Wallops Island, Va. Each of the seven men will ride Redstone missiles launched from Cape Canaveral, Fla., during 1959-1960.

This will be followed by two Jupiter firings, also from Florida. Ten booster shots using the Atlas missile are scheduled for the final phases of the program.

A low-cost, high-production-rate satellite is now in the works. The NASA vehicle has three stages—all powered by solid-propellant rockets. First stage is the Aerojet 100,000-pound thrust (Jupiter Senior) engine. Second stage is a Thiokol Sergeant rocket. Third stage will be by Allegany Ballistics Laboratory.

The entire rocket will be about 70 feet long and will weigh close to 35,000 pounds at launch. It will be able to put some 150 pounds of payload into a 300-mile-high orbit. Chance Vought has been selected as the systems contractor.

According to ARPA, the current military needs in space will be satisfied less than 600 miles from the earth. This excludes near space probes (to the moon, Mars, and Venus). Deep space probes (to near Pluto or some 3 billion miles from the earth) will be attempted by NASA by 1962 with the multimillion pound thrust rocket engines now under development.

The Air Force, it is said, is planning to send man to the moon by 1968. Booster rockets with 16 million pounds of thrust will be able to handle vehicles weighing 5 million pounds and over. The Air Force would establish a manned moon base using this type of huge vehicle. Man would make the trip from earth, spend some twenty days on the moon, and then return to the Earth.

All these satellite and space-probe experiments are expensive and will become even more expensive when man enters the picture. The year's program for unmanned space projects is now pegged at about $1 billion. A limiting factor, for example, is said to be the ground support equipment required to sustain such projects.

For example, about 70 per cent of the military missile cost is invested in ground support equipment. A test ICBM launch complex runs about $19 million. Each new vehicle will require its own peculiar ground equipment.

Orbiting one pound of equipment costs about $1,000. Cost to deliver 10 pounds of material to the moon would be about $10,000. Supplies for one man in space for one week would weigh about 283 pounds and would cost about $250,000! A stamp to cover the cost of sending a microfilm letter to the moon would run about $25!

Propulsion.—The ultimate in chemical propellants—fluorine and hydrogen—both are moving (as yet independently) toward eventual practical use in high-performance rocket systems.

Bell Aircraft Corporation has received a $1.2 million contract from NASA to carry its fluorine rocket engine tests further. The firm has been firing small-scale rocket engines using liquid fluorine as the oxidizer. This oxidizer, the most vigorous chemical known, is highly reactive with many common materials. The big problem lies in handling the toxic oxidizer and in finding compatible materials for storage, lines, and engine parts.

The balance tips more heavily in favor of fluorine when nitrogen fuels (such as ammonia or hydrazine) are used. With nitrogen fuels, liquid fluorine as an oxidizer has a performance of some fifty seconds greater specific impulse than liquid oxygen.

On the fuel front, liquid hydrogen is beginning to show up. The Air Force will be supplied with tons of the potent fuel by a West Coast plant.

At the present time it looks like hydrogen will soon be teamed with oxygen. The NASA Centaur rocket will use a second-stage liquid hydrogen-liquid oxygen rocket engine. Under development now by Pratt & Whitney, two engines—each developing 15,000 pounds of thrust—will be used.

Other high-energy fuels figure big in this Nation's space plans. Upgrading petroleum jet fuels by hydrogenation has been suggested. However a synthetic organic fuel, diethylcyclohexane, is being studied as a replacement for the jet fuel (RP-1) used in the Atlas missile. However, the nitrogen fuels (such as ammonia) are receiving careful attention for manned vehicles like the X-15.

Mr. Zaehringer, president of the American Rocket Company, Wyandotte, Mich., is a recognized authority on astronautics, guided missiles, and jet propulsion.

••••RADAR SIGNALS FROM SPACE•••••

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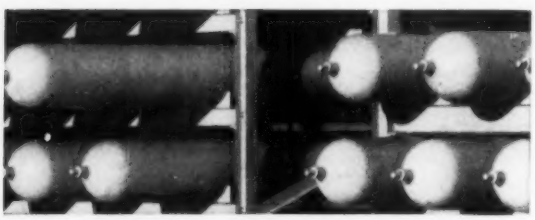

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Airborne Digital Computer.—Wright Air Development Center has sponsored the development of a small, lightweight, multifunctional digital computer of advanced design which solves most navigational problems in both aircraft and missiles. The AN/ASN-24 computer uses silicon transistors throughout and is capable of solving problems in high-Mach-number aircraft. Its extremely small size and weight and rugged design make it applicable for guidance in a wide range of missiles.

The computer is compatible with TACAN, celestial, inertial, and Doppler radar systems, as well as inputs from radio, true airspeed indicators, and various heading applications. The computer is manufactured by Librascope, Inc., weighs about 32 pounds, and occupies approximately half a cubic foot of space.

Mobot.—At the Atom Fair and Nuclear Congress held in Cleveland recently, a Mobot manipulator—a remotely controlled mobile robot with flexible steel hands and television-camera eyes to handle dangerous radioactive materials in "hot" areas—was displayed by Hughes Aircraft Company. It is anticipated that perhaps this Mobot may be the first "man" to land on the moon. The Mobot can "see" in all directions since cameras mounted atop the machine afford forward and rear views, and cameras on its "shoulders" provide close-ups of the "fingers" at work. A microphone allows the operator to hear the Mobot's metal fingers grasp objects. The device can be equipped with many auxiliary tools such as wrenches, screwdrivers, hammers, and shears.

Gyro Platform.—A contract has been negotiated between the weapons system manager of the B-70 intercontinental bomber and the Sperry Gyroscope Company to develop and manufacture a precise reference system for the bomber. This twin-gyro platform is composed of highly accurate accelerometers and gyroscopes which will provide the B-70 air crew with accurate attitude and heading reference in any weather, day or night, at any point on the earth. The B-70 is expected to operate at about three times the speed of sound and at an altitude of about fourteen miles above sea level.

The lightweight twin-gyro system is a new form of basic flight reference, differing in major aspects from conventional 2- or 3-gyro platforms in use today. The system employs two identical directional gyros set at right angles to one another to create a platform which will remain stable in space despite aircraft maneuvering.

Moptar.—The Federal Aviation Authority will use the Cubic Corporation Moptar (multiobject phase tracking and ranging system) for checking the operation of various air-traffic control systems at FAA's research and development facilities in Atlantic City. This installation will measure paths of five aircraft simultaneously, within a radius of five miles, to determine accuracy of tracking and traffic control systems presently under development. It is reported that the system is capable of tracking ac-

Lieutenant Colonel Van Vliet, U.S.A.F. (Ret.), formerly director of armament electronics, Northeast Air Command, and formerly chief of the Operations Division, Air Force Ammunition Services, is an electronics systems engineer in the California Division, Lockheed Aircraft Corporation, Burbank, Calif.

AN ASW SYSTEM... DISPLAY/AIRBORNE RECEIVER/SONOBUOYS

Anti-submarine warfare equipment designed, developed and produced by *The Magnavox Company*, in conjunction with the Navy Department, provides patrol aircraft with eyes that see underwater by day and by night. The AN/ASA-16 Display System, together with SONOBUOYS, AN/ARR-26 Receiver systems and other associated equipment provide aircraft with a clear picture of the ocean-depths below them. They are part of the continuing contributions of *The Magnavox Company* in aiding the U.S. Navy to combat the growing submarine menace.

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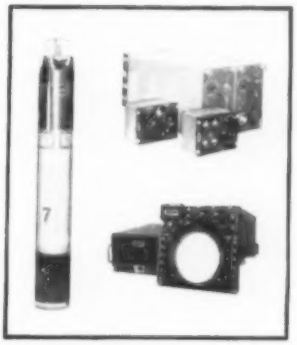

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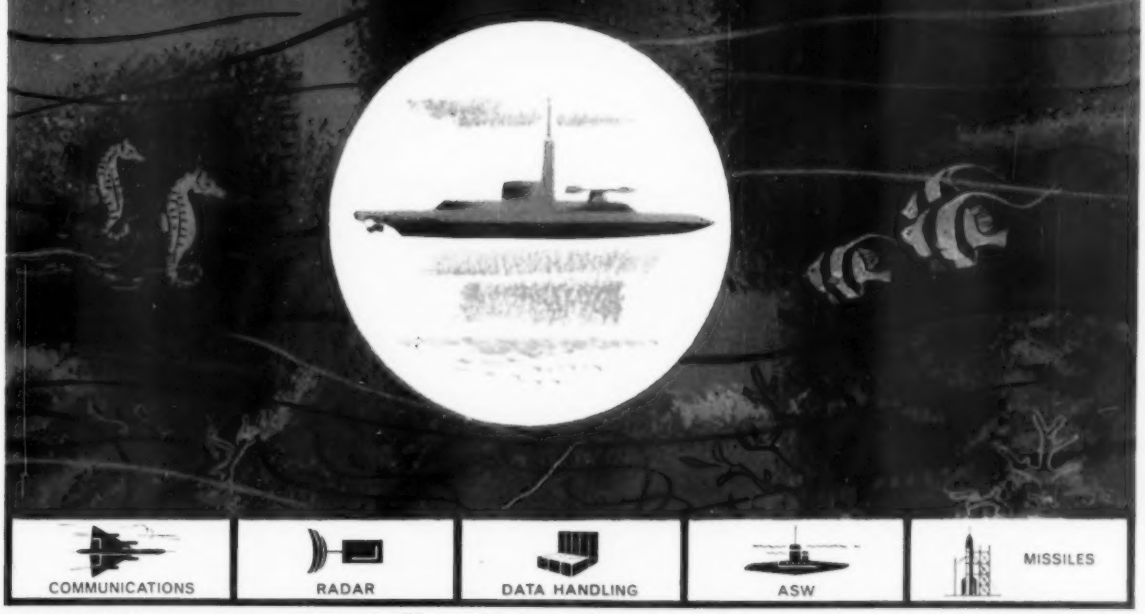

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Armament Electronics (Contd.)

curacy within 5 feet on aircraft within a 200-mile radius and should lead to closer control of aircraft in congested areas.

Radio Sextant.—The Navy's COMPASS ISLAND has been equipped with a Collins radio sextant, AN/SRN-4, which was developed under a research and development contract from the Navy's Bureau of Ships. The data obtained from the radio sextant, coupled with other navigational information, determine precisely the ship's position and true north. The sextant is capable of tracking both the moon and sun under all weather conditions from rising to setting.

The heart of the sextant is an extremely sensitive radio receiver which measures thermal radiation in the short microwave region. The receiver uses a 5-foot parabolic antenna and operates on a wave length of 1.8 centimeters. The potential applications of the radio sextant are many. It allows rendezvous of vessels during radio and radar silence and permits safe approach to fogbound coasts. This system has considerable civil application, as well as military, and opens the way for safer travel at sea.

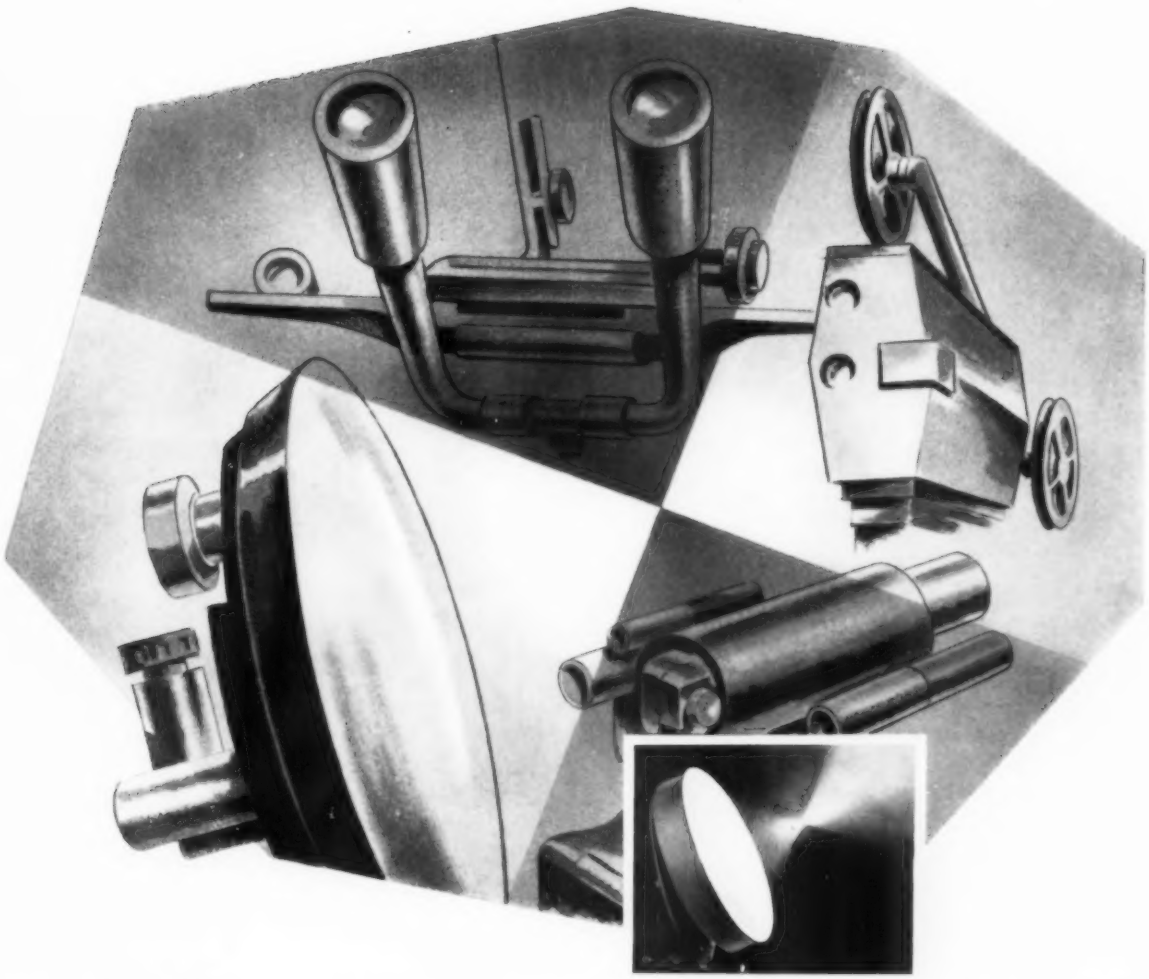
Submerged Celestial Fix.—The Navy recently disclosed a device called the submarine celestial altitude recorder (SCAR), which enables a submarine to take a celestial fix from periscope depth while submerged. When the moon, sun, or stars are sighted, a switch on the scope is actuated and the exact altitude of the celestial body is computed automatically. This computation provides angle of sighting in degrees and minutes and the time in hours, minutes, and seconds, and the data are printed instantaneously on paper.

Missile Tracking.—The Department of Defense and NASA will combine efforts to provide a combined satellite and space-probe tracking network which will include an extension of the present Minitrack system with stations in Alaska, the United States, Newfoundland, and Canada. Stations in Hawaii, Texas, and Bermuda are for tracking and control of manned satellites. Additional stations will be established in Australia and South Africa, Spain, and Japan.

High-Power Radar.—The Army Ordnance Corps is sponsoring a study involving a high-power radar system to solve the problems of microwave propagation and long-range missile tracking in connection with the Plato antimissile system. The Ordnance Corps, acting as a contracting agency for the Advanced Research Projects Agency, has directed this development to Cornell Aeronautical Laboratory. The ultimate goal of the new program will be to extend the 21-million-watt peak power at S-band frequencies to 50 million watts. This will be accomplished at various pulse lengths and repetition rates. It is believed that the average power may go to 50,000 watts.

Weather Radar.—The Weather Bureau and the Air Force are planning a nationwide weather radar system which will provide faster and more accurate forecasting based on radar systems and automatic data processing systems. The new field of radar meteorology is apparently growing quite rapidly and promises to provide almost instantaneous weather mapping of the entire United States. The Department of Commerce and the Federal Aviation Agency will cooperate with the Weather Bureau and Department of Defense to create a national and a global weather system.

A test network of nine radar weather stations will be established in a line extending from Boston, Mass., to Norfolk, Va., to provide observations which will be sent to a central location where large area weather maps will be prepared at one-hour intervals. It is hoped that this weather central will be a forerunner of a national weather system which will aid not only in air travel but provide essential information to those who depend on accurate weather information.



Unbreakable Repli-Kote Mirrors out-perform glass, slash costs

These new lightweight, low distortion Repli-Kote Mirrors of cast epoxy resin offer design engineers optical reflectors with a matchless combination of properties, impossible with glass. A single master mirror is all that's necessary for mass producing precision Repli-Kote Mirrors—at significant cost savings.

Optical Precision — 6″—5¼″ Focal Length Repli-Kote paraboloid mirrors have been produced in quantity with an accuracy permitting 90% of incident collimated light to be concentrated within a disc of 0.1 mm diameter. Higher rate of thermal diffusion through epoxy also lowers distortion caused by temperature transients.

Permanent Reflective Surface — High vacuum applied, silicon monoxide protected aluminum reflective surface is *permanently* bonded to epoxy backing, will resist flaking or peeling for extended periods.

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Any Shape—Paraboloids, hyperboloids, ellipsoids and more complex aspheric surfaces not previously reproducible in glass by mass production methods can now be quickly fabricated.

Ease of Mounting—Fixtures, threaded inserts, electrical components can be molded directly into the mirror backing, opening an almost limitless field of design possibilities. Repli-Kote Mirrors are also easily machined.

If you are working on tracking and guidance systems—or any system employing reflective optics—durable, lightweight, precision Repli-Kote Mirrors offer you greater design and production freedom. Let us help you make the most of Repli-Kote Mirrors in building a better product at lower cost.

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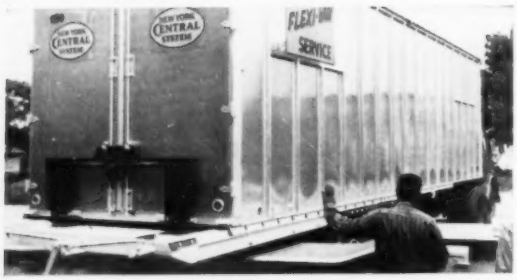

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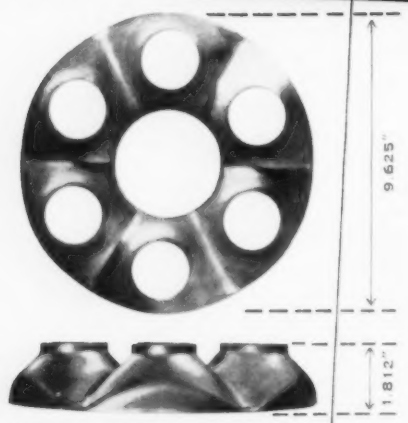

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RECENT PATENTS

Compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each.

Noise Reducer for Gun.—*U. S. Patent No. 2,868,078. Issued January 13, 1959, to William J. Jarrett, Assigned to the Secretary of the Army:* This invention provides means for reducing the audible noise of discharge of guns. As shown in Figure 1, the gun barrel 14 is provided with an extension, secured to

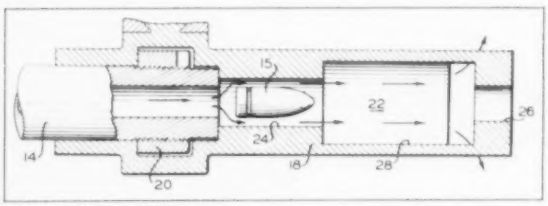

Fig. 1. Noise-reducing device attached to gun barrel.

the gun by a nut 20. This extension includes a first chamber 24 and a second chamber 28 of larger diameter. The front end of the second chamber 28 is terminated by a flange with an aperture 26 extending through it.

Some of the gases propelling the projectile escape into the second chamber 28 before the projectile enters it. The discharge gases vibrate in the same manner as gases passing through a supersonic whistle.

Safety Device for Rockets.—*U. S. Patent No. 2,866,415. Issued December 30, 1958, to Cass R. Roquemore, Assigned to the Secretary of the Navy:* This invention provides a simplified removable safety attachment for a loaded and assembled rocket which, without altering the construction of the rocket, renders it nonpropulsive until the attachment is removed. In the event the rocket should be fired accidentally during shipment, the attachment deflects the gases radially, thus eliminating any axial thrust and canceling out all transverse thrusts.

Cathodic Protection of Ships.—*U. S. Patent No. 2,863,819. Issued December 9, 1958, to Herman S. Preiser:* This invention relates to the cathodic protection of ships' hulls against corrosion caused by galvanic action. The normal methods involve the use of sacrificial anodes or DC-energized anode systems involving cumbersome and heavy anodes close to the hull. These increase the drag on the ship and have to be replaced periodically. The energized system also requires careful current regulation, special wiring, etc.

The present invention overcomes these disadvantages by utilizing an insoluble anode of negligible resistance properly connected to a DC-source and trailing it behind the ship at a certain distance to ensure current distribution throughout the ship's hull.

Artillery Training Device.—*U. S. Patent No. 2,863,394. Issued December 9, 1958, to Andre Losfeld:* The object of this invention is to provide an arrangement for reducing the calibers

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Recent Patents (Contd.)

of artillery equipment with guns having smooth or rifled bores so that live firing can be carried out with projectiles of reduced size and range. It is intended to enable instructional firing to be done without appreciable wear of the equipment and with economy in the cost of the projectiles.

Explosive Charge for Delay Fuze.—*U. S. Patent No. 2,865,726. Issued December 23, 1958, to Hugh P. Jenkins, Jr. and Charles H. Shomate:* This invention provides a method for controlling the rate of detonation of initiating explosives by adding to the primary explosive a waxy material (*e.g.*, aluminum stearate or stearic acid). The waxy material coats the particles of explosive and fills the interestices between the particles. The invention is particularly applicable to primary explosives such as lead azide and mercury fulminate.

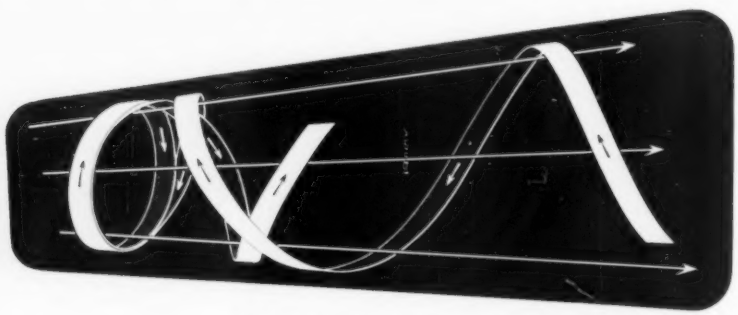
Liquid Rocket Fuel.—*U. S. Patent No. 2,865,727. Issued December 23, 1958, to Jay W. De Dapper. Assigned to North American Aviation, Inc.:* This invention provides an improved liquid rocket motor fuel for use with turpentine, employing nitric acid as an oxidizer. It has been found that the addition of a small amount of lithium aluminum hydride to the turpentine promotes the reaction of the nitric acid with the turpentine to such an extent that dependable instantaneous combustion may be obtained even under adverse conditions. It is preferable to dissolve the lithium aluminum hydride in an ether in order to increase the extent to which it can be dissolved in the turpentine.

Deterrents for Smokeless Powder.—*U. S. Patent No. 2,865,728. Issued December 23, 1958, to Ralph L. Cook. Assigned to Olin Mathieson Chemical Corporation:* This invention relates to new and improved deterrent materials for coating progressive-burning smokeless powders. Smokeless-powder grains are surface-treated with deterrents in order to obtain maximum projectile velocities with minimum breech pressures in the firearm. The deterrent coating decreases the combustion rate of the initially burning portion of the powder grain. The usual deterrent materials migrate into the grains on storage and thus lose their effectiveness. This disadvantage is avoided by using a coating of a diisoalkylphthalate having three to six carbon atoms in the alkyl group.

Releasable Mounting.—*U. S. Patent No. 2,867,396. Issued January 6, 1959, to Quinton C. Johnson. Assigned to the Secretary of the Air Force:* This invention provides a mechanism for temporarily supporting disposable or jettisonable objects such as auxiliary fuel tanks on an aircraft wing.

Flare Device.—*U. S. Patent No. 2,868,129. Issued January 13, 1959, to Thomas H. Johnson, Ernest M. Kane, and John O. Tabor, Jr. Assigned to the Secretary of the Navy.*—This invention provides a construction in which the cap sealing the rear end of a flare and supporting the ignition squib is formed of a thermally destructible substance, and a number of openings are formed through the cap for venting the ignition gases generated by the squib. After the charge has commenced burning, the temperature generated within the flare causes the cap to be completely melted. Thus there is no danger of the cap injuring a tracking aircraft. Furthermore, any constriction at the rear of the flare is avoided.

Miss-Distance Indicator.—*U. S. Patent No. 2,843,028. Issued July 15, 1958, to William C. Ward and Newton E. Ward. Assigned to the Secretary of the Navy:* This invention describes a training aid for increasing the marksmanship of pilots of fighter aircraft. The device provides the pilot with a picture which shows the direction and magnitude of such error as may have occurred while making an attack on a target within minutes after the attack is made.



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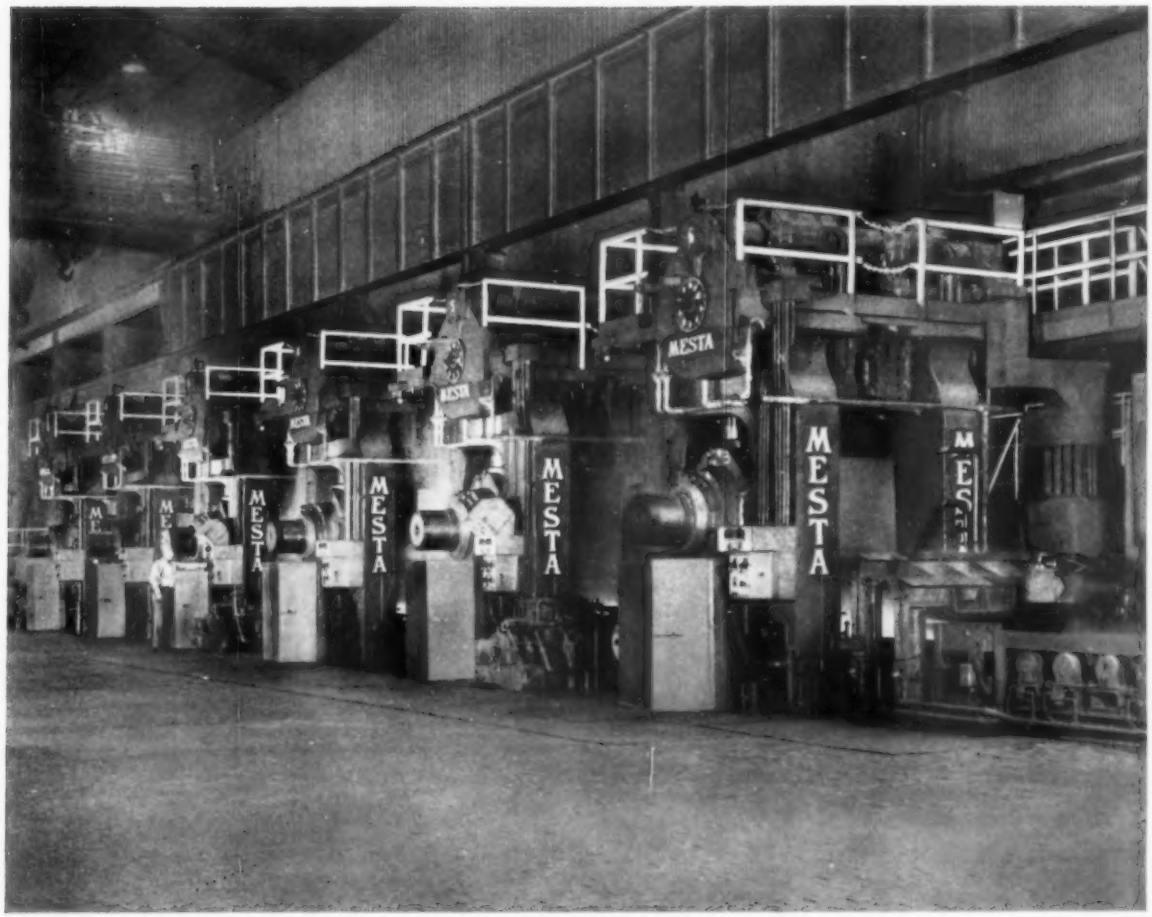

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Jones & Laughlin equips hot strip mill with double-poured Ni-Hard working rolls

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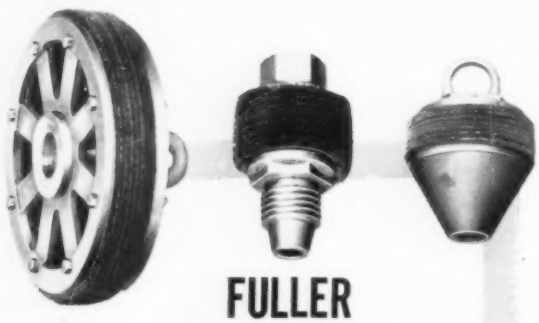

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Book REVIEWS

Reviews in this issue by:

LOREN E. BOLLINGER, *registered professional engineer, research associate, Ohio State University, Columbus, Ohio.*

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

LEO A. CODD, *editor, Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

P. A. VAN OVER, *assistant editor, Washington, D. C.*

Brave Men and Great Captains. By R. Ernest Dupuy and Trevor N. Dupuy. Foreword by Lieut. Gen. James M. Gavin. New York: Harper & Brothers. 378 pp. $5.95.

THIS is American military history at its best. It is a thrilling, realistic portrayal of leadership as well as a critical analysis of some of the battles in which our Army has engaged from Bunker Hill to Korea. Restrained, impartial, objective, the text crystallizes the elements of character, ability, and drive that have become part of our national military tradition and—nearly always—inspiration.

The authors are among the best equipped to present such a study. A father-and-son team, this is not their first book. "Military Heritage of America," published in 1956, is recognized as a serious and comprehensive analysis of American military history from the Nation's birth, with highlights of major campaigns, many maps and charts, and an extensive bibliography.

R. Ernest Dupuy, senior member of the team, published a compact history of the United States Army in 1956. These and other products of their talented pens long since established them among our top American military historians.

The present volume reconfirms their title to such recognition. With the objectivity essential to the historian, they have chosen from among our Army leaders certain of them whose achievements and failures have influenced our national life. Here are the highlights of battles, the analysis of decision—heroic or bungling—all epitomized in the one quality, leadership. The canvas is broad; the artistic treatment excellent. All the greats are on parade: Washington, Scott, Grant, Lee, Jackson, Pershing, MacArthur, Patton, Eisenhower, and the rest. There are thirty-five detailed maps.

Students may differ as to the final appraisal in particular instances, but none can dispute the superior craftsmanship of the authors or contest the obvious effort they have made for objectivity.—LEO A. CODD.

War and the Soviet Union. By H. S. Dinnerstein. New York: Frederick A. Praeger, Inc. 268 pp. $5.50.

THIS book is number seventy-nine in the publisher's series on Russia and Communism. The author, an experienced research analyst, has made an exceptionally thorough study of Soviet

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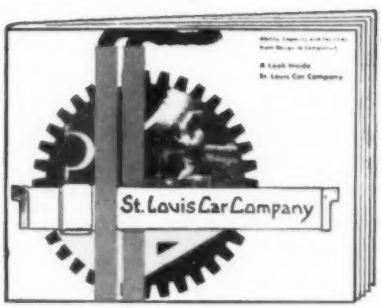

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military publications, and has presented his analysis in seven well-arranged chapters which depict the changing Soviet outlook, the fears and the preparations for a "preemptive" war from the Soviet viewpoint, the Soviet ideas on how a war might be initiated, and the possible conduct of a nuclear war.

Some interesting conclusions can be drawn from reading this material. Under Stalin, industrial managers and army chiefs were capriciously liquidated for offering any objections to his plans, however impractical. The technical demands of specialized nuclear equipment, more than any liberality on the part of Khrushchev, seem to have loosened the freedom of expression. Soviet rulers are aware that party politics will not produce rockets and nuclear equipment, and there is perhaps a suspicion that if the new generation of technicians are not satisfied with political conditions they can turn the bomb back on the politicians.

This attitude, however, is not wholly in favor of the West, because it has served to activate the party into intensive propaganda to unify the Soviet people into a belief that they are in dire peril from a possible attack by the capitalist nations. The book is well worth careful study as an exposition of devious Soviet reasoning.—GEORGE S. BRADY.

The Marauders. By Charlton Ogburn, Jr. New York: Harper & Brothers. 307 pp. $4.50.

A MARCH of 600 miles through the "forbidding fighting country" of northern Burma brought fame and overdue recognition to the bravery of three American battalions known as Merrill's Marauders. With the mission of establishing a ground base to send supplies to China and ultimately make possible air assaults from the Chinese mainland upon Japan, Galahad, the mission's official name, battled its way across the murderous terrain from January 15th to May 17th, 1944.

A cooperative venture, Galahad was jointly commanded by Chiang Kai-shek, Adm. Lord Louis Mountbatten, and Lieut. Gen. Joseph W. Stilwell, who left the stamp of his character upon the entire operation. Mismanagement and constant bickering at the top were typical during each phase of Galahad, making it a war fought in the vacuum of official forgetfulness.

A member of this famous fighting force, Mr. Ogburn writes with the sharp details known only to one who was a part of the operation. Markedly objective in his descriptions, he still gives the reader an amazing insight into the cold business of war, when bravery consists of being able to take the next step.

Despite official inattention, the brilliant leadership given by each of the battalion commanders and their officers made the Marauders a tough and vicious fighting force which ultimately won out against the jungle, the Japs, and physical disability.—P. A. VAN OVER.

In Every War but One. By Eugene Kinkead. New York: W. W. Norton Company. 219 pp. $3.75.

THIS is an amazing book, and the facts it reveals are of such major national import that every American citizen worthy of the name should use his influence to help remedy the conditions it describes. The facts it reveals are proof positive of a major weakness of our much vaunted American way of life.

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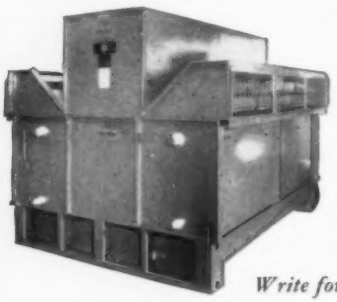

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Book Reviews (Contd.)

collaborated with his Communist captors and why two out of five died, many at the hands of their fellow Americans!

True, the political aspects of the Korean war were a national disgrace. We entered a conflict we were not allowed to win. Little wonder that the fighting men were confused and, at times, disgusted. But history will take care of that. The best we have been able to do to prevent a repetition of such actions on the part of our fighters who are captured by an enemy is the Army Code of Conduct—a last-ditch effort to instill understanding, courage under stress, and patriotism.

But the Code can only take us part of the way. Possibly it will help bring the Army in combat somewhere near the Marines who attribute their much better record to their leadership, discipline, and rigorous training.

In Korea the Turks led all the rest in their stolid resistance to Communist threats and cajolery. And probably here lies the real answer to this crucial national problem. Until discipline is again bred into young America, in the home, in the school, and in the church—until there is an attitude of responsibility toward American institutions, their history, their cost of attainment, their basic rights and, above all, their duties—there will be no adequate solution. Putting the citizen into uniform cannot remake the individual.

This book points out the handwriting on the wall unless parents, educators, and clergymen themselves get back to first principles and demand that those under their guidance mend their ways. The record of our men taken captive in Korea is a sorry indictment of the education and training of the young American long before he is given the honor and privilege of wearing the military uniform.—Leo A. Codd.

Sea Devil of the Confederacy. The story of the Florida and her captain, John Newland Maffitt. By Edward Boykin. New York: Funk & Wagnalls Company. 306 pp. $4.95.

Boykin, who has to his credit the story of "Raphael Semmes and the Alabama," has successfully combined in the present work a nerve-tingling tale of adventure, a competent biography of a raider as brilliant as Semmes (yet whose name is nearly forgotten today), and a view of the American Civil War that has been amazingly neglected.

All history has its "ifs," many of them at least possibilities, yet Boykin's thought, that had the Confederacy immediately concentrated on the export of cotton and the procurement of steam fighting ships her chances might well have tipped the scales of fate, is truly a fascinating approach to the probabilities.

The cold facts of history are nigh incredible, both in the damage done by two or three cruisers and in the amount of military supplies and cotton that succeeded in entering and leaving the ports of the South. The author shows that the key to this is the amazing boldness and skill of such men as Maffitt, Semmes, and Read.

Their exploits, and the flow of cotton brought such enthusiasm in Europe that a large extension could well have made tremendous difference to the South.—F. W. Foster Gleason.

Conductance Design of Active Circuits. By Keats A. Pullen, Jr. New York: John F. Rider Publisher, Inc. 330 pp. $9.95.

Design of active electronic circuits employing normal electron tubes and the newer transistors is complicated because of inherent nonlinear characteristics. Dr. Pullen has presented a different approach to the problem by employing conductance techniques to circuits using tubes and transistors instead of conventional procedures.

Essentially, the nonlinear circuits are linearized on a point-by-point basis. Written primarily as a textbook, the author first reviews some basic principles of electronic circuits. Following a

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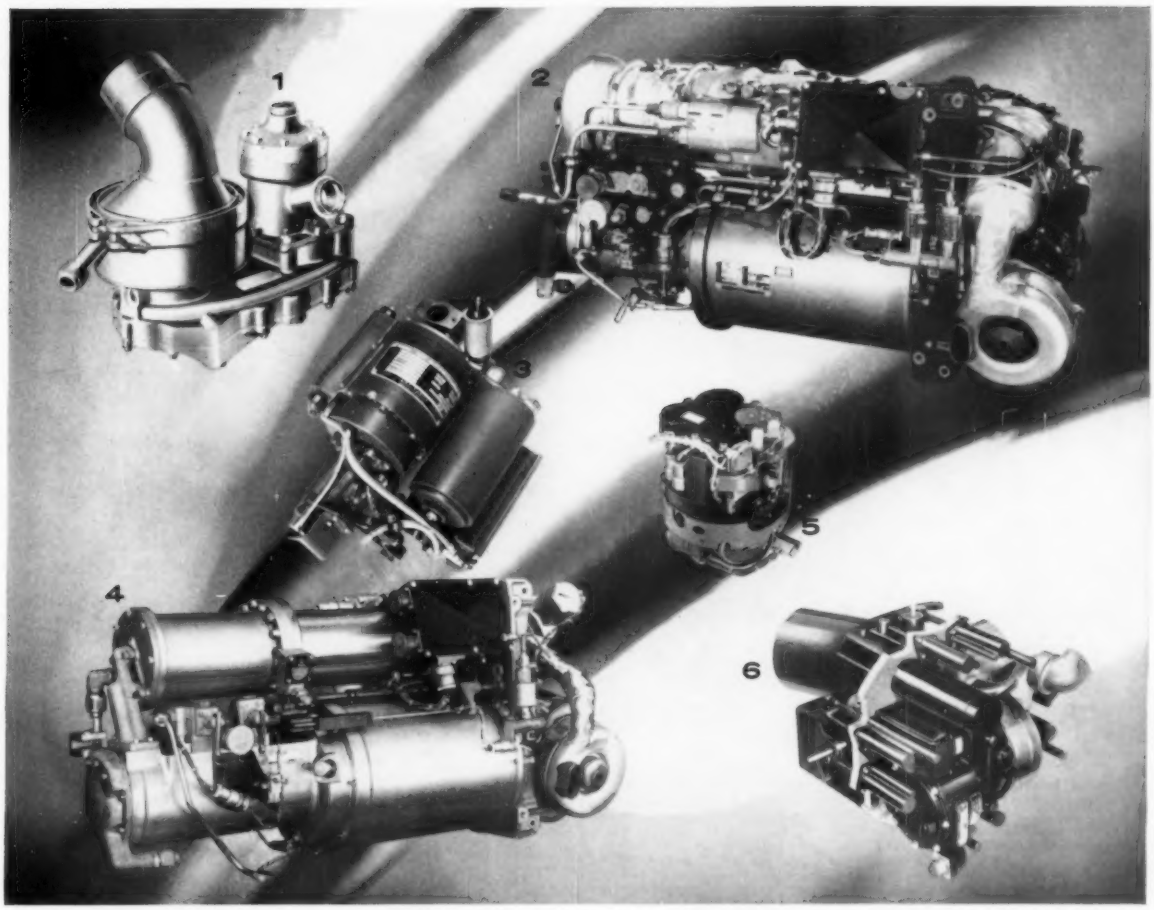

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Book Reviews (Contd.)

discussion of how the data are presented and the design of simple circuits, he considers impedance and power amplifiers, R-F and I-F amplifiers, and special circuits. The sections on sine-wave oscillators and multivibrators are very interesting.

The last three chapters contain material on mixers and detectors, transistor amplifiers, and high-frequency transistor circuits. This intermediate textbook is well written and the author is to be congratulated for presenting techniques to reduce the problems of circuit design.—LOREN E. BOLLINGER.

Gardner's Photographic Sketch Book of the Civil War. By Alexander Gardner (republished from original 2-volume edition of 1866). New York: Dover Publications, Inc. 100 plates. $6.

THIS was the first published collection (1866) of Civil War photographs. Fortunately, it has been reprinted without changes, preserving the "flavor" of the times by the rather quaint words of the text.

It comprises an interesting selection of scenes of both locations and persons. Ordnance is well represented, though without much authoritative text or continuity. Perhaps the greatest promise of worth to the average reader is to prepare him to understand the many works which are even now appearing in advance of the coming American Civil War centennial.

To the student of eastern battlefields, it would surely be of value to carry this book while touring locations, demonstrating the changes of the intervening years.—F. W. FOSTER GLEASON.

BOOKS RECEIVED

A-C Circuit Analysis. Edited by A. Schure. New York: John F. Rider Publisher, Inc. 104 pp. $1.80.

Air Force Blue Book, The. Edited by Tom Compere. New York: Military Publishing Institute, Inc. 384 pp. $1.00 paperbound; $4.95 hard cover.

Army and Economic Mobilization, The. Volume V of subseries, "The War Department" under general series, "United States Army in World War II." By R. Elberton Smith. Washington: U. S. Government Printing Office. 749 pp. $5.25.

Dictionary of Guided Missiles and Space Flight. Volume V in series, "Principles of Guided Missile Design." Edited by Grayson Merrill. New York: D. Van Nostrand Company. 688 pp. $17.50.

Government Missile Agencies, 1959 Directory of. Edited by the editors and staffs of "Federal Procurement and Subcontracts Daily" and "R & D." New York: Federal Procurement Publications, Inc. 133 pp. $15.

Guided Missiles, 1959 Directory of. Edited by the Editors and Staffs of "Federal Procurement and Subcontracts Daily" and "R & D." New York: Federal Procurement Publications, Inc. 122 pp. $15.

Helicopters and Autogyros of the World. By Paul Lambermont. New York: Philosophical Library, Inc. 255 pp. $10.

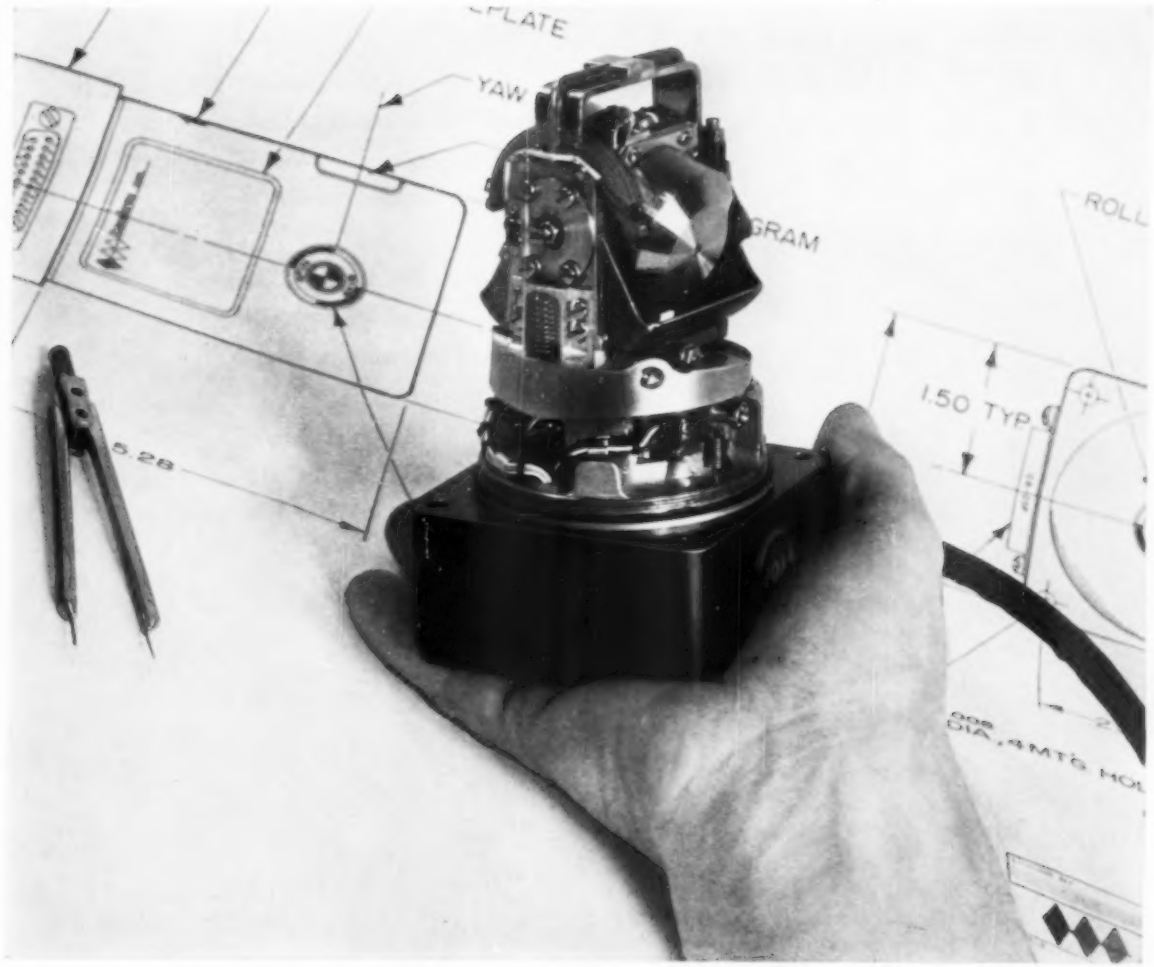
Mathematics Dictionary. Edited by Glenn James and Robert C. James. New York: D. Van Nostrand Company. 546 pp. $15.

Rocket Encyclopedia Illustrated. Edited by John W. Herrick and Eric Burgess. Los Angeles: Aero Publishers, Inc. 607 pp. $12.50.

Stuka Pilot. By Hans Ulrich Rudel. New York: Ballantine Books. 239 pp. $0.50 (paperbound).

Trading Stamp Practice and Pricing Policy. Edited by Albert Haring and Wallace O. Yoker. Bloomington: Indiana University. 390 pp. $6.

Video Amplifiers. Edited by Alexander A. Schure. New York: John F. Rider Publisher, Inc. 88 pp. $1.80.



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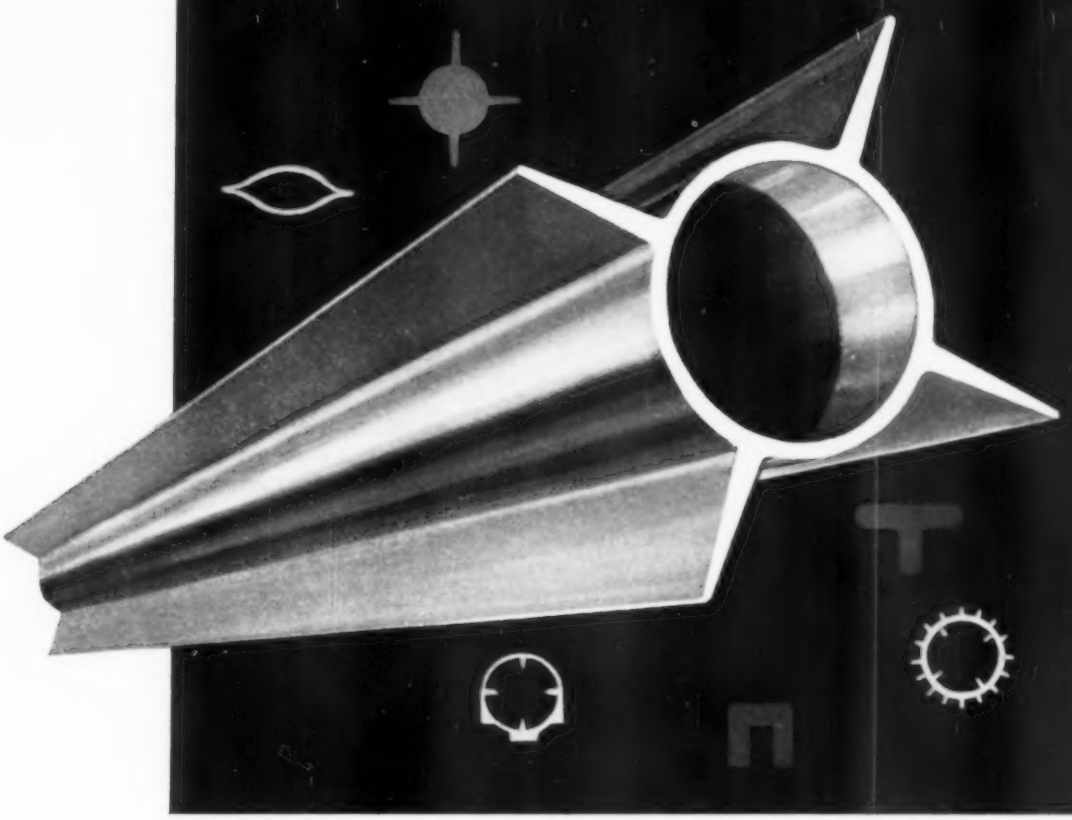

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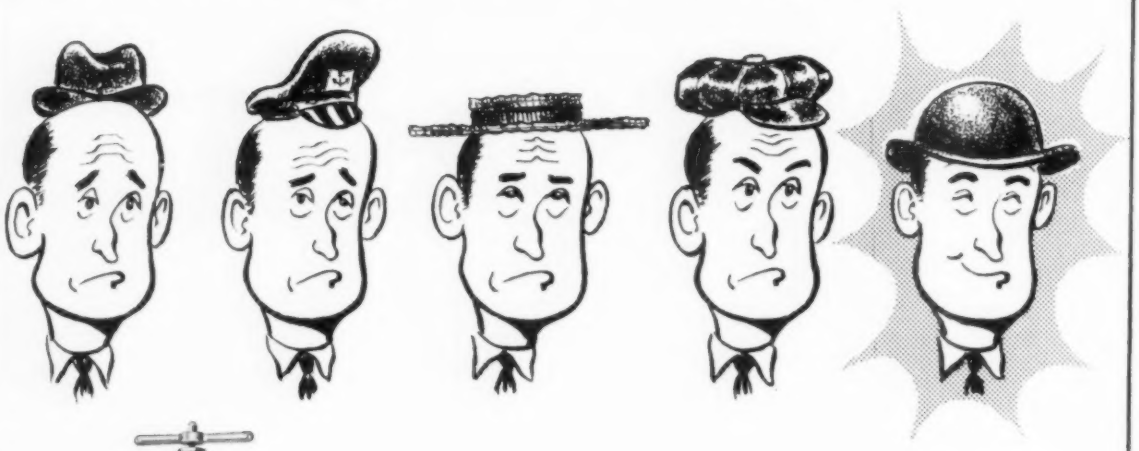

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Armament Technology

This section of ORDNANCE contains selected papers on armament technology presented at meetings of Technical Divisions and Sections of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use

Saga of the Light Tank

Thirty years of development for the armored reconnaissance vehicle

Robert W. Forsyth and John P. Forsyth

THE history of arms development is nothing more nor less than a history of conflict—conflict between nations and the bloodless, but at times equally bitter, conflict between the technician, his patron, the military advocate of revolutionary tactics, and their archfoe, the military conservative, the protector of the *status quo*.

As in all such conflicts between the old and the new, the military conservative, though frequently enjoying temporary victories, eventually was soundly defeated. The breech-loading rifle, the machine gun, the submarine, and the airplane all caused such conflicts; so also did the tank.

HOWEVER, when first introduced to warfare, albeit prematurely in the Battle of the Somme, September 15, 1916, the partial success of the first crude tanks fortunately inspired further development, and they were used with increasing success by the Allies and the Central Powers until the Armistice. Thus in the first round of the tank conflict, victory went to the technician and the military revolutionary.

But with the signing of the Armistice the reaction set in, and the horse cavalry was again emphasized to the detriment of tank development.

With the advent of World War II, the internal-combustion engine's domination of the battlefield, and the tank's undeniable monopoly of combat mobility in ground warfare, victory came once again to the technician and the military revolutionary, and it seemed, with regard to tanks at least, that it would remain theirs.

But now, some fourteen years later, we find that victory being challenged and the role of the tank in war being questioned again. There are those who feel that the ground attack airplane, guided and unguided antitank missiles, and nuclear weapons will result in concentration on development of a heavily armored, heavily gunned tank.

FORTUNATELY the Army, and Army Ordnance in particular, does not feel that the usefulness of the tank has come to an end. On the contrary, operations and research analysis reveals that armor will be equally useful on the atomic or nonatomic battlefields of future wars.

Armor provides maximum troop protection from nuclear attacks. It can be quickly dispersed in the face of such attacks and quickly massed to exploit our own use of nuclear weapons. We see, therefore, that armor provides the Army with firepower, mobility, protection, and a means of quickly reacting to enemy attacks.

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Leo Steinhardt
Integrating all factors

M3A1 light tank with 37-mm. gun (Army photo).

M1 combat car foreshadowed WW II light tank (photo, Col. R. J. Icks).

The contention that future tank development will be limited to heavy tanks is refuted by the Army's tank-development policy which calls for maintenance of our present tank family of heavy, medium, and light tanks and evolvement of a main battle tank (a combination heavy and medium), an airborne assault weapon, and a light tank.

Of the three tank types planned for the future, the light tank probably evokes more questions as to its value than the main battle tank or the airborne assault weapon. Most can grasp the need for a main battle tank to combat enemy armor when on the defense and to break through and spearhead attacks by our armored forces. And of course airborne forces require assault support and an antitank weapon; thus the need for an airborne assault weapon.

But why, in this age of the super weapon, do we need a light tank? Aren't light tanks fitted with the thinnest armor and the lightest gun? They may be fast, but once engaged by enemy armor aren't they always destroyed?

Because these same questions have always been asked regarding the light tank, it is best to review its evolution in America during the past three decades, examine the design trends, explore possible future developments, and finally scrutinize current doctrine governing its employment to provide the answers.

As a result of the National Defense Act of 1920, tanks became the exclusive property of the Infantry, and although interest was expressed in light tanks as early as 1922, Army Ordnance was not directed to develop a light tank until 1926. Unfortunately, specifications called for tanks so light as to be impractical, but experience gained by Ordnance designers engaged in the program paved the way for the development of the T2E1 and T2E2 light tanks.

These tanks were produced by the Rock Island Arsenal in 1935 under the designation M2A1 and M2A2. They both weighed approximately 19,000 pounds, were fitted with a maximum of 5/8-inch armor, and mounted one caliber .50 and three caliber .30 machine guns. A maximum speed of 45 miles an hour on a paved road was attained by the use of a 250-horsepower Continental engine complemented by a sliding-gear transmission. The major difference between the two tanks was the mounting of two turrets on the M2A2 as opposed to the single turret of the M2A1.

Variation of these two tanks, called "combat cars," were known as the M1 and M2. Although both differed from the tanks, in that 360-degree-traverse

The M22 tank with 37-mm. gun could be transported by glider (Army photo).

The 1942 M5A1 light tank still had 37-mm. gun (Army photo).

By 1951 a 76-mm. gun was used on the M41 tank (Army photo).

turrets were installed, the M2 "combat car" represented the most radical change since it was powered by a T1020 Guiberson Diesel engine.

Further refinements of the two basic light tanks resulted in the production of the M2A3 in 1938. This was an improved version of the M2A2, mounting two turrets with a caliber .50 machine gun located in the left turret. Maximum armor was ¾-inch, causing an increase in weight to approximately 26,000 pounds and a slight decrease in performance.

A major step forward in light tank design was taken in 1939 with the introduction of the single-turret, 37-mm.-gun M2A4. A 4-man tank, equipped with three caliber .30 machine guns in addition to the main gun, the M2A4 carried maximum armor of one inch on vertical surfaces, and was powered by either a Continental radial gasoline engine or the Guiberson Diesel, complemented by a synchromesh transmission. Two drive sprockets were located at the front of the tank. Track suspension consisted of two bogies for each track with vertical volute springing of the two rubber-tired road wheels making up each bogie. The M2A4 weighed 23,000 pounds.

In 1940 a further improvement of the M2A4, the M3, was placed in production. It varied only slightly from the M2A4, the chief distinguishing characteristics being a trailing idler wheel and a turret offering greater crew protection. The M3's weight of 28,000 pounds was moved by a 242-horsepower Continental gasoline engine.

The quantity production of the M3 by American Car and Foundry Division, ACF Industries, Incorporated, not only reflected the demands of preparation for World War II but also proclaimed the end of an era of tight budgets for tank development and procurement.

With the demand for increased armament for light tanks temporarily satisfied by the incorporation of a 37-mm. gun in the M2A4 and the M3, Army Ordnance next focused its attention on providing increased crew protection and improving power plants and power transmission. The first product of this effort in a new direction was the M3A3 light tank, similar to the M3 in many respects but fitted with a welded hull and turret which overcame the multiple shortcomings of riveted construction.

Incidentally, the M3A3 was the last light tank powered by the Continental radial, air-cooled, aircraft-type engine, for the M5, a 37-mm.-gun light tank which made its debut in 1942, was powered by 2 modified Cadillac automobile engines generating a total of 250-horsepower.

The 76-mm.-gun tank T92, now being evaluated, is designed for air transportability (photo, Aircraft Armaments, Inc.).

The M24, armed with a 75-mm. M6 gun and concentric recoil mechanism, was the final light tank development of World War II (photo, General Motors).

Another advanced feature of the M5 was the use of two Hydramatic transmissions. This arrangement eliminated the need to shift gears manually and enabled the driver to concentrate on maneuvering his tank. A subsequent modification of the M5, the M5A1, differed from the original only in that the turret was manufactured with an aft bulge to provide additional space for radio equipment.

At the same time as these more or less conventional light tanks were being produced, specifications were laid down for a 7.5-ton tank to be air-transported and employed by airborne forces. A prototype vehicle, developed by Marmon-Herrington, was selected from several vehicles designed to the specifications, and an improvement of the prototype, designated the T9E1, was produced in 1942. Redesignated the M22 in 1944, close to a thousand of these tanks were built prior to the end of the war in Europe in 1945.

ALTHOUGH a comparative stranger to combat, the M22 nevertheless possessed several interesting characteristics, the most noteworthy being its small size. Over-all dimensions of 68½ inches high, 155 inches long, and 87¾ inches wide, and its total weight of less than 8 tons enabled its transport intact by the British Hamilcar glider. The British, incidentally, originally had been the chief advocates for its development. Unfortunately, its light armament (a 37-mm. gun and a caliber .30 machine gun and light armor (a maximum of one inch, which had been adequate at the time of its conception) caused the M22 to be declared obsolete in 1945.

But to return again to a chronological evolution of the light tank. As the war progressed, Army Ordnance was faced with demands by Army Ground Forces to develop a more adequate weapon. With the ultimate refinement of the original M2A1 and M2A2 tanks resulting in the M5A1, weight had increased to 32,340 pounds without an accompanying increase in firepower. Therefore Army Ordnance, in cooperation with GM's Cadillac Division, developed the M24 light tank.

Incorporating a 75-mm. M6 gun with a concentric recoil mechanism, an Ordnance refinement of an aircraft cannon, the M24 also was equipped with improved fire control in the form of a gun elevation stabilizer and a power-operated turret. Torsion-bar suspension, employed in conjunction with large rubber-tired road wheels, resulted in greater mobility for the M24 and utilization of the full potential of the 220 horsepower produced by its two Cadillac engines.

As with the Cadillac-built M5A1, two Hydramatics took care of power transmission. It should be noted that with the introduction of the M24, World War II light tank development ended.

The current standard American light tank, the M41 (and modifications thereof), was introduced in 1951 following several years of exhaustive postwar research by Army Ordnance. Primarily designed for use on reconnaissance and security missions, the 52,000-pound M41's high speed of 40 miles an hour is made possible by its Ordnance-Continental, 6-cylinder, air-cooled, 500-horsepower engine. A unique cross-drive transmission combines the functions of an automatic transmission and a steering unit.

Armament consists of a high-velocity 76-mm. gun equipped with a bore evacuator and a blast deflector, supplemented by caliber .30 and caliber .50 machine guns.

The very latest American light tank being evaluated by Ordnance is the 36,000-pound T92, developed by Aircraft Armaments, Incorporated. This new light tank mounts a 76-mm. high-velocity gun, flanked by a caliber .30 and a caliber .50 machine gun. Designed for air-transportability from the outset, most characteristics of the T92 still are classified; however, it is logical to assume that performance will be superior to present equipment.

The foregoing review of the evolution of the American light tank makes apparent many design changes, such as the development of automatic fire control, the use of automatic transmissions and power-assisted steering units, and improvements in crew protection. However, the most significant trends are in the areas of armament and weight.

WITH regard to armament we note that the M2A1 and M2A2 were equipped with machine guns whereas the T92 mounts a 76-mm. high-velocity gun. As for weight, we note that every increase in armament caused, until very recently, a corresponding increase in weight, from approximately 19,000 pounds for the M2A1 and M2A2 to 52,000 pounds for the M41.

As indicated, however, this trend toward increased weight for the light tank has been reversed with the introduction of the 36,000-pound T92. In view of this it is logical to assume that future light tank design will be directed toward increased firepower but without the penalty of increased weight.

Regarding increased firepower, future developments eventually may bring about the use of antitank missiles as main armament. Although this may seem farfetched, primarily because of a lack of stowage space in existing light tanks, further developments in the areas of thrust-stabilized rockets, more potent warheads, and automatic feeds may make it practicable.

As a possibility meriting consideration in the immediate future, the employment of an in-turret-loading re-

coilless rifle as main armament holds much promise. One apparent advantage in such an application is the elimination of a recoil mechanism with its attendant weight and space requirement with "fringe benefits" of lower initial cost and ease of maintenance.

FOR those who feel a recoilless rifle would not be equal to the task, it might be well to compare the capabilities of our current 106-mm. recoilless rifle with those of our current conventional 90-mm. gun—remembering, of course, that the former is proposed for use on a light tank; the latter is presently used on the M48 medium.

First, the 106-mm. recoilless has an effective range of roughly 1,500 yards; the 90-mm. an effective range of about 2,000 yards. Secondly, the 106-mm. recoilless shell is superior to the 90-mm. shell in ability to penetrate armor. It is worth noting that 106-mm. ammunition is available in forward areas, since Infantry antitank teams use it, whereas only units equipped with the M48 medium tank or the M56 self-propelled gun use 90-mm. ammunition.

The one major disadvantage of the mating of a recoilless rifle with a light tank is the powerful back-blast accompanying each firing of the weapon, representing a potential hazard to troops following the tank and using it to cover their advance. However, it should prove to be no great feat to develop a blast deflector or similar device to eliminate this hazard.

Future changes in basic light tank design to achieve weight reduction will undoubtedly assume many forms. Some of the more promising approaches to this problem might well include the housing of the entire crew in the turret, thereby eliminating the need for a separate driving compartment and reducing the area to be enclosed by protective armor.

Another possibility would be to place the tank driver in a prone position when the tank is "buttoned up." It is estimated that this simple expedient would reduce over-all vehicle height by some 15 inches and reduce fighting weight by roughly 18 per cent. The extensive data developed by the United States Air Force during its investigation of the feasibility of the prone position for pilots should provide an ideal basis for research on the application of this innovation to the drivers of light tanks.

As to the role of the light tank in future conflicts, current Army doctrine states that:

FUTURE combat action will necessitate better knowledge of enemy dispositions, capabilities, and intentions. The increased dimensions of the battlefield and accompanying demands for intensified intelligence effort, target acquisition, and surveillance of the enemy emphasize reconnaissance. To meet this demand we must have reconnaissance which is improved in penetrating ability, protection, and possesses the facility of fighting for information in all conditions of terrain and weather. This means armored reconnaissance ground elements in close coordination with air-transported reconnaissance and battle-area surveillance units.

THUS to sum up and answer, in inverse order, the three rhetorical questions we posed earlier in this article:

Yes, light tanks are fast, and indications are that they will be faster in the future, but this very swiftness usually ensures against their being engaged by heavy enemy tanks. And even if engaged, increased firepower will enable American light tanks to give a good account of themselves.

Yes, light tanks are usually fitted with the lightest armor and the lightest gun, but advances in metallurgy and armament may yet bring the day when light armor is not synonymous with weakness and a light gun is not necessarily synonymous with a lack of firepower.

For an answer to our first question—Why a light tank in this age of the wonder weapon?—we beg the reader to review the quote regarding the Army's increased reconnaissance requirements in future combat.

Principal characteristics of light tanks from 1935 through 1957.

Year	*Model*	*Max. Armament*	*Max. Armor-in.*	*Speed-m.p.h.**	*Range-mi.***	*Wt.-lbs.*	*Engine h.p.*	*Crew*
1935	M2A2	Cal. 50-m.g.	⅝	45	200	19,400	250	4
1940	M3	37-mm. Gun	1	36	60†	28,000	242	4
1942	M5(M5A1)	37-mm. Gun	1½	40	98	32,340	250	4
1942	M22	37-mm. Gun	1	40	135	15,800	162	3
1944	M24	75-mm. Gun	1½	34	100	40,500	220	4-5
1951	M41	76-mm. Gun	—	40	120	52,000	500	4
1957	T92	76-mm. Gun	—	—	—	36,000	—	—

* Maximum road speed.
** Cruising range, average operating conditions.
† Some versions were powered by the Model T-1020 Guiberson Diesel engine. Performance was the same except that range was increased to 84 miles.

Missile Management

There were many problems involved in organizing the resources of the military departments and of American industry to develop the Polaris fleet ballistic missile system within the scheduled time

G. O. Pehrson

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THE scope, content, and, most importantly, the complex interdependencies of the many parts of the total Fleet Ballistic Missile Program must be generally sensed as a preface to an understanding of how it is being managed.

In this program there is, of course, Polaris—the long-range seagoing ballistic missile. Launched from submerged, fast, and far-ranging nuclear submarines, this missile, and the total weapon system of which it is a part, will represent a truly unique contribution to our total defense effort.

As a specific weapon system it will combine the concealment opportunities of the vast and free ocean depths with the speed and range opportunities of outer space. As a technical achievement it will combine the productive use of nuclear reactors for submarine propulsion with the destructive power of thermonuclear warheads.

AS a vital asset in our total defense equation, it will provide the deterrent influence of known inevitable retaliation against an aggressor. There is no significant part of any continental land mass that will lie beyond range, immune to the retaliatory action of this planned weapon system.

Any report on management of this program must, at this point, pause and clearly recognize that we have what is perhaps the greatest single resource to apply against the problems of managing complex operations—the motivation of high purpose. We believe that through this program a known position of military strength can be established from which our country can meet its changing world responsibilities without loss of direction toward permanent world peace.

From these beliefs we find in all persons working on this total job a degree of dedication that is truly our strongest single reason for success to date.

With this fact recognized, the story of our management approach becomes a report of the Navy facing up to the problem of creating a new military capability in a shorter period of time than has ever been attempted before under nonmobilization conditions. A "complete military capability" means more than building a missile and a submarine with all its associated shipboard weapon subsystems. These are the "hardware" parts of a military capability.

To these must be added the men who will operate and maintain the total weapon system. Men must be selected, trained, motivated, and provided for in the near-space-ship environment of the modern nuclear submarine on extended patrol. Medical and human engineering considerations form important parts of the total program.

To attain a complete military capability, we must add to these the operational and logistic supporting activities which bring men and matériel together at points of military application. The number and variety of these supporting projects are too numerous to mention. They range from assembly depot and submarine tender facilities to special procedures designed to ensure optimum response from a supply supporting system.

THE scope of activities involved in this total program can be defined in many ways. In geographic terms, work is being carried out all over the country. The types of work run the entire scale from microscopically delicate adjustments in laboratories to the riveting of steel in drafty shipyards. There are few, if any, fields of knowledge in the physical sciences which are not being tapped for some contribution to this program.

All parts of the Navy are involved in building this new fleet-ballistic-missile capability. There are over 3,000 known contractors who have, in varying degrees, some part of this total job. Over $2 billion already have been appropriated for this program, and the first Polaris submarines will start joining the fleet next year.

This defines *what* has to be managed—the complete "program package." It is a program that has been consistently defined and presented in total terms. It is a program that has been reviewed and approved in terms that permit completely integrated and balanced planning and administration.

This simple fact of having a program that includes all elements of a total decision is the second part of a report on the management of this program. This unity of program has permitted the establishment of a comprehensive pattern for management that supports the administration of this project as a total integrated effort.

This means, for example, that the price of every proposed part of this total job is clearly and directly identified with it. The decisions made on the size and content of the program are made with a clear understanding of the price that must be paid. This covers not only the parts funded in budgets annually presented to Congress but also the costs of the total decision as they represent claims on future defense budgets.

CONGRESS does not consider this program in the separate parts of missiles and ships and supporting pieces. Congress is presented with a completely integrated fleet-ballistic-missile "program package." While funds are provided for this program in a number of separate Navy appropriations, such as shipbuilding, research and development, procurement of ordnance and military construction, congressional action is addressed to the total program proposed.

These funds when appropriated and made available to the Navy are placed in a separate management fund.

These special budgetary and funding arrangements have streamlined and strengthened the procedures of program management. They have made it possible to establish completely integrated procedures for estimating, controlling, and accounting for funds.

The problem of organizing the resources of the military departments and of American industry to the vast common purposes of this program, and do it within the discipline of tightly scheduled periods of time, required many early Navy actions. There were two which were most important:

First, an assignment of the "highest priority" was given to all work required in support of this effort. This priority designation has been retained, and the value of this singular status in Navy programs cannot be overstated.

Secondly, a "program-management team" was established which was directly responsible to the Secretary of the Navy who served as chairman of a Navy Ballistic Missile Committee. This team consists of the Special Projects Office of the Bureau of Ordnance. A relatively small professional and supporting staff, including both military and civilian members, was formed. The Director of this Office, Rear Adm. W. F. Raborn, was given authority to draw talent from any part of the Navy to staff his organization.

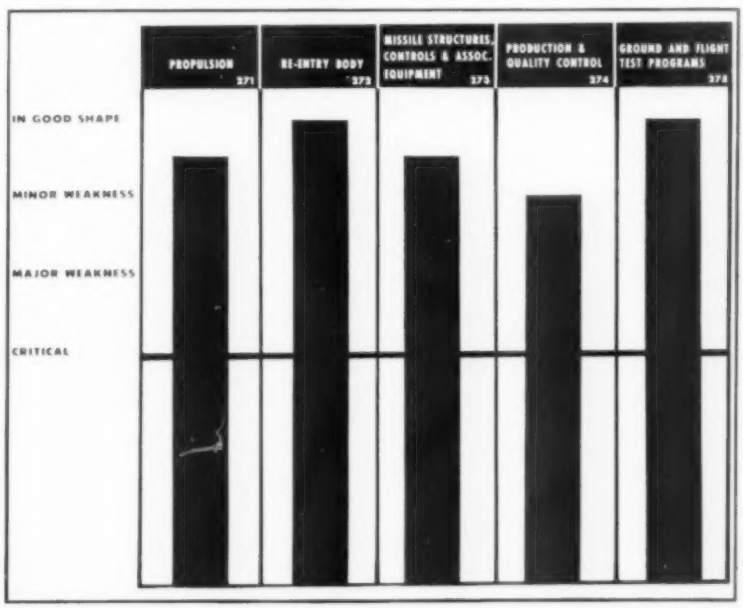
The scope of this director's responsibility is as broad as the scope of the approved program itself. It grows as the program has grown. The scope of his authority is in balance with his responsibility, and he has responsibility for defining, scheduling, and assigning the work that has to be done to carry out the approved program. He has authority to require coordinate response to his assignments regardless of where the work is to be done and he has control of the resources required to support his assignments.

This arrangement could have created more difficult problems than it solved. However, it has been possible to tap and successfully use the existing talents and facilities of the Navy for this job without creating a new large Government agency that would have to duplicate functions already being performed for all the other important Navy programs. The work that had to be done has been done efficiently and on time.

THE Special Projects Office, or "SP" as it is called, deals directly with industry in technical matters and in procurement. It is, in effect, a "management contractor" within the Navy itself, the first such organization to be established. It is a funnel through which military needs and development know-how of all types pass into the industrial facilities that produce and assemble the actual matériel and back into the military facilities which provide the tests and training inherent in carrying any new weapon to the operational stage.

The planning and programming of the project involves some rather staggering numbers. There are about 400 major programs involved, with literally thousands of subprograms. The tight timetable allows no margin for guesswork or slippage. The job of SP is to ensure that each item is at the right

Fig. 1. Status of major components in a typical Polaris missile project.



place, in the right degree of completion, at the right time. And every item must be developed and obtained outside of the Special Projects Office itself.

To do this job, a program-planning and control system has been established that has aroused great interest and received serious study by many of the largest corporations in this country. Many of its basic principles and some of its specific procedures have been given the highest of compliments in that they have been adopted by some corporate managements. They have been adopted for use by companies which also have been seeking answers to their management problems—answers to the new problems of managing large-scale decentralized operations in these days of rapid changes in which so many new decisions of adjustment must be made.

THE system is simple in its form and concept, but it is comprehensive in its coverage of all parts of the total program effort. It provides a quick and inexpensive way of ensuring that there is balance of the thousandfold parts that will make up the final result. But it does this within a flexible framework of control and reporting that permits adjustment to the many changing influences that bear on the program.

The core of the programming and control setup rests on simplifying the four fundamentals of planning, coordination, evaluation, and communication.

With the simplification of the programming function there has been an equal simplification of the reporting function. Here, too, some new "furrows" have been plowed. With thousands of contractors engaged in developing or making every conceivable type of component, hundreds of thousands in all, a small "management team" could very easily grow into a large "management team" in simply keeping track of the progress of these items. This trend has been stoutly resisted.

To tie the reporting of individual projects as closely as possible to the demands of the program as a whole, a very simple "qualitative" scheme of reporting and charting has been devised, so that a diversity of elements can be evaluated and compared realistically and quickly.

Figure 1 is a typical chart of where a project stands as of a specific date. Note that it breaks the status down into four broad qualitative categories, each identified with a simple, understandable phrase. It takes no study or special indoctrination of "key" to find out what the chart reports, basically, about its program.

The four phrases, however, do have a very specific meaning in SP.

"In good shape," says in three words: "Everything I proposed to happen last week that I thought would represent progress *did* happen . . . I am happy the way things are going."

"Minor weakness" might be paraphrased as: "Something happened that I didn't think would happen . . . But this is a relatively small matter that I can take care of without help."

"Major weakness" says, in effect: "Boss, I need your help," and, finally, "Critical" can be translated into: "Boss, you're going to need some help."

This qualitative concept of reporting has been applied also to the reports generated within the organizations of the various contractors and contributing agencies. As a result, the status of thousands of components of varying complexity and importance can be evaluated in terms of the ultimate qualitative appraisals into which any figures, dates, or percentages must be translated before they become meaningful to those who must do something about them. Action is not taken on figures, but on the situations which these figures reveal.

By using the same terms used at every reporting level, and by giving these terms a common meaning, a great deal of misunderstanding and slippage has been averted as well as thousands of words of more conventional "reports."

FINALLY, however, management involves more than planning, reporting, evaluation, and communication—it involves decisions. In the case of SP, as in any project involving hundreds of thousands of items and billions of dollars, to say nothing of its impact on national security, it involves many hundreds of decisions—military, technical, administrative, operational, and fiscal.

One system that we have developed and installed in several complex branches of the program is a computer operation that solves mathematically a whole range of problems in programming and prediction. It is called "Pert," standing for "program evaluation and review technique."

It operates on the principal of "simulation," wherein tens of thousands or even hundreds of thousands of individual calculations are made in minutes to measure the impact on delivery schedules of wide numbers of possible variant elements or variants.

Already it has more than proved its worth in actually shortening delivery times or in showing us what must be remedied to coordinate the flow of components to meet the target dates established.

"Pert" requires our contractors to do detailed thinking and analysis of the job requirements in advance, thus materially improving their understanding of the job and bringing into sharp focus the critical path of its requirements. In short, it gives management the most critical path in a development process which management should keep its eye on and assigns the proper weight or importance to the many supporting efforts.

WE have touched briefly in this report on the purpose or the "why" of the FBM program. We have found in this purpose one part of the management story—the values of strong and sustaining personal motivation of all persons working on the job.

In the content of the program, the things to be managed, we have noted a second part of this management experience. This program has been planned, approved, and is being administered as a total military-capability decision. All types of work, in all phases through which a total program moves to completion, are being held together as parts of a complete "program package." The special organizational arrangements for administering the approved program have been noted.

Finally, a few highlight notes are included covering the operation of a program planning and control system which has been an effective means for establishing a new type of relationship between the Special Projects Office—the total "weapon-system contractor"—and all the participating elements in Government and industry.

Electronic Components

Before the performance goals set by the Air Force can be reached and the required items designed, considerably more information must be obtained on the properties of materials

Lieut. Col. J. S. Lambert

IN a modern air weapon system the electronic equipment is an integral part of the air vehicle, and it cannot be separated readily from the airframes or the power plant. It controls and guides the aircraft during flight, provides air-to-air and air-to-ground communication, sights targets, releases bombs, aims and fires the guns, and even monitors fuel consumption.

The more advanced the weapon system, the more dependent it becomes on electronic equipment. The number of antennas on a modern aircraft is a good indication of the electronic equipment it carries.

The advent of supersonic air vehicles has created an entirely new class of environmental conditions. Although specific information on such conditions is still lacking, we know that in many cases the environment is so severe that currently available electronic equipment, even though protected and shielded, cannot survive in it for any reasonable period of time.

AS the operational features of the different types of air vehicles are not the same, neither are the environmental conditions in them alike, and they may vary considerably from one vehicle to another. Since such environmental conditions may be difficult to predict while an air vehicle is in the design stage, the only logical approach the designer can take is to provide for the vehicle the most rugged equipments available.

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Since the Air Force continues to fly a large number of aircraft at subsonic speeds and will continue to use electronic equipment on the ground, the environments to which such equipment is being subjected vary from quite moderate to very severe. Because of this spread in environmental conditions, the Air Force is beginning to group the electronic component parts, from the standpoint of application, into three distinct classes as follows:

1. Commercial.—This class includes the type of components developed for and used in industrial applications and home entertainment equipment.

2. Air Force "conventional."—These are components developed to withstand the more severe applications encountered in equipment of subsonic aircraft and in ground electronic systems.

3. Air Force "nonconventional."—This class encompasses all applications encountered in air vehicles and weapons designed to fly at supersonic speeds.

Table II shows a comparison in the maxima of the environmental conditions' parameters that electronic component parts are being or are expected to be subjected to in the near future covering the three classes of applications mentioned above.

The first parameter listed is that of temperature. The highest temperature that commercial components in general are being designed for is 85 degrees centigrade. The intent is to use as few of these in Air Force equipments as possible. In their place the improved JAN type shown in the second column should be available. These should work satisfactorily in ambient temperatures as high as 125 degrees centigrade. The nonconventional applications, in some cases, are expected to reach ambient temperatures as high as 500 degrees centigrade.

TO illustrate why such high-temperature operation is required, picture a chart with the adiabatic wall temperature of the leading edge of an aircraft plotted against the aircraft's speed in Mach numbers. Two curves would be shown: the upper one for sea-level flight, the lower one for flights roughly between 46,000 and 100,000 feet. It may be noted that above Mach 2 the temperatures begin to rise rather rapidly.

For any given air vehicle the temperature encountered in flight is a function of altitude as well as Mach

number. For example, sea-level flight at Mach 2 yields an adiabatic wall temperature of about 270 degrees centigrade, whereas flight at the same Mach number and at 50,000 feet yields a temperature of just over 100 degrees centigrade. However, at Mach 3 at the same altitude this temperature is over 300 degrees centigrade.

At the higher speeds and altitudes some heat from the power plant will be retained by the aircraft. This, added to the heat dissipated by the equipment and to the heat due to solar radiation absorbed by the aircraft, will raise the ambient temperatures within the aircraft to a point much higher than our electronic materials and component parts of today can safely withstand.

BECAUSE of the many variables, it is not possible to specify readily the temperature ranges within any aircraft except in very general terms. Some estimates were made of aircraft compartment temperatures at several Mach numbers and at 50,000 feet. These are shown in Table I. Typical equilibrium temperatures are shown which might be expected at Mach 2.2, 2.8, and 3.3.

These temperatures are for equipment directly exposed to ram air, equipment in an isolated area of the aircraft, equipment protected by cooling systems, and electronic equipment generating heat and then cooled. It should be noted that at Mach 3.3 and at an altitude of 50,000 feet, equilibrium temperatures as high as 250 degrees centigrade are being reached around electronic equipment.

Simulated conditions have been created to show what happens at very fast speed flights within the atmosphere, and photographs clearly show successive deterioration due to excessive heat of a test vehicle in an NACA wind tunnel under simulated aerodynamic conditions that would occur at 50,000 feet and 4,500 m.p.h. or at about Mach 6. Under these conditions the vehicle burns up completely in a very short time.

It is obvious that under high-speed conditions ram air will not be low enough in temperature or large enough in volume to provide any effective cooling. Studies show that at the speeds and altitudes considered, refrigeration equipment may produce more heat than it can remove. In manned aircraft it will be a difficult enough problem to insulate and shield the aircraft crew without considering the shielding or protection of equipment. This points up a definite need for electronic equipment capable of operation at high ambient temperatures.

Listed next in Table II as the important parameters to be considered in the development of component parts are shock and vibration. These result essentially from the method of propulsion and from the density and condition of the air through which the vehicle passes. It is being found that the initial shock experienced on a take-off due to the gradual rise of the thrust and the spreading of the impact over a relatively long period of time is not as great as might be expected.

The shock resulting from the disengagement of the booster may be more critical than the initial thrust because of the shorter time period in which it occurs. An upper shock limit of 100 G has been assumed for future aircraft equipment.

The frequency of vibration, with modern propulsion methods and with increasing speeds, has risen to a point where, in certain instances, it reaches 3,000 cycles at about 60 G. A variable frequency of vibration may, in many instances, be superimposed on a constant frequency.

In the large missiles, such as the ICBM, the low-frequency vibrations, due to the sidewise motions of the missile, are very bothersome. These, varying from about 30 to 250 cycles a second, produce wide excursions and cause extensive damage to electronic equipment.

In addition to the mechanical vibration, the modern power plant often introduces a high volume of noise. This could reach 190 db above the reference level (of 2×10^{-4} dynes/cm^2) and will cause acoustical-type vibration. Transmitted to the aircraft equipments, this vibration is suspected of causing fatigue in metals, delamination of plastics, and displacement of critical structures.

SOONER or later a firm requirement is expected to be stated for electronic components to operate in specific nuclear radiation fields. It is rather well known that nuclear radiation affects almost every material, and generally with a detrimental effect. For instance, it changes the electrical characteristics of dielectrics and insulators, and in structural materials causes changes so they no longer perform properly.

It is being found that, in general, damage to a material is a function of the total energy absorbed by the material; that is, of the cumulative amount of nuclear particles to which the material is exposed and which it retains and is not dependent on the rate of radiation.

The intensity of nuclear radiation fluxes shown in Table II is quite high. For instance, preliminary results show that transistors suffer permanent damage at a total dosage of from 10^{13} to 10^{15} gamma photons per cm^2 or a total of 10^{13} neutrons per square cm. Some damage to transistors is generally evident at an NVT (integrated dosage, where N is the number of neutrons, V the velocity, and T the time) of 10^{11} per cm^2 the better transistors are still useful at 10^{12}, but very few will operate at an NVT of 10^{13}. Circuit operation at these dosages generally depends on the design tolerances.

Table I. Compartment temperatures of high-speed aircraft at 50,000 feet.

	Equilibrium, Surface, or Coolant Inlet Temperature		
Components	*M 2.2*	*M 2.8*	*M 3.3*
Equipment directly exposed to ram air, external structure	170°C.	250°C.	400°C.
Equipment in isolated area, uncooled but some insulation	125°C.	175°C.	270°C.
Protected by cooling systems	85°C.	110°C.	170°C.
Electronic equipment (cooled)	115°C.	170°C.	250°C.

Parameters	*Commercial*	*Air Force*	
		Conventional	*Nonconventional*
Temperature (maximum)	85°C.	125°C.	500°C.
Shock	Moderate	10 G's in 10 millisecs.	100 G's in 10 millisecs.
Vibration	Moderate	10 to 55 cps. at 10 G's 55 to 3,000 cps. at 20 G's	5 to 55 cps. at 30 G's 5 to 3,000 cps. at 60 G's Air induced: up to 20,000 cps.
Sonic disturbance (reference level: 2×10^{-4} dynes/cm.^{2})	Fair	150 db.	190 db.
Nuclear radiation fluxes	Moderate (varies)	Moderate (varies)	Gamma: 10^{11} per cm.^{2} per sec. Neutrons (fast): 10^{13} per cm.^{2} per sec.
Life (hours)	3,000 (expected)	1,000 (minimum)	1,000 (desired)
Expected Air Force application	0	95%	5%

Table II. Classes of applications of electronic component parts.

The Air Force has tested many of the available component parts in nuclear radiation fields under dynamic (operating) conditions. In many cases the integrated dosage (NVT) exceeded 10^{18} neutrons per square cm. The overall results have been rather encouraging. For instance it has been found that the total flux of 10^{18} neutrons/cm^2 has little effect on wire-wound resistors, glass dielectrics, or mica capacitors.

On the other hand, ceramic capacitors are somewhat affected as are resistors other than wire-wound, and glass in electron tubes becomes discolored and brittle. It also has been found that paper and electrolytic capacitors and organic type of insulation are not satisfactory for this environment.

In general, the preliminary conclusions from these tests are that many high-temperature-resistant components and materials are also tolerant of nuclear fluxes and that many components of lower quality are more radiation resistant than the more refined components. Metals sustain the least damage, inorganic (nonmetallic) materials are damaged to some extent, and organic materials suffer the greatest damage.

THE life of a component part, or its reliability, is a very important factor in the design of Air Force equipment. However, the state of the art of equipment reliability, for equipments operating under normal environmental conditions, is far from satisfactory. Because of this it becomes a more difficult problem when the severe applications are considered, particularly since the life of any component decreases as the severity of conditions in which it works is increased.

There are several other problems that must be considered, such as the effect that cosmic rays at very high altitudes may have on aircraft equipment. There are also the problems of long-time storage, the effects of prolonged ground testing, of moisture, dust, and of similar conditions.

The last item shown in Table II is the expected Air Force application of component parts of the different classes. The Air Force is striving to have military-type component parts in all its equipments. The nonconventional applications should not require more than five or six per cent of the total number of component parts used by the Air Force.

In going from the second to the third class of component part applications there is a significant increase in all the parameters. However, it is the feeling of the Air Force that there is no point in subdividing the third class, or the nonconventional applications, into additional subclasses. In the first place, due to the many variables involved it would be difficult to determine accurately beforehand, that is in the design stage, what the environmental conditions in any particular application would be. Under such conditions, each designer will want only the best components in his system so as not to take a chance on the failure of a million dollar system for the difference between a $5 and a $25 component.

Also, if the nonconventional type of components were subdivided into additional subclasses, the multiplicity of component parts for a limited number of applications would not only become complex but would also be very expensive. Therefore, for the more severe applications, the Air Force proposes the use of only one class of components.

There is also another factor that has a great bearing on the case. There will be but few selected bases capable of maintaining the nonconventional type of weapons. Limiting all nonconventional applications to only one class should streamline the logistics considerably.

THE environmental conditions were considered one by one. However, seldom, if ever, will only one severe environmental condition occur in an aircraft, a missile, or space ship. For instance, high temperatures are expected in environments in which large nuclear radiation fluxes will be present or shock is expected to be accompanied by vibration and so on.

The toughest parameter to solve for in the new environment may be that of high temperature. It is hoped that if any component satisfies this parameter it also will satisfy the others; that is, that materials and components which meet the high-temperature requirement will also survive under the other conditions. This is true in some cases; for instance, ceramic tubes which are high-temperature-resistant also appear to be tolerant of nuclear radiation and withstand a good deal of shock.

Regarding requirements, the importance of any parameter over another depends largely on the problem requiring solution at a particular time. Three years ago stress was placed on nuclear-radiation tolerance. Two years ago the high-temperature requirement became important due to the increase in the speed of aircraft flight. At present low-frequency vibration appears to be the most critical parameter.

In the effort to develop component parts for severe environmental conditions the Air Force is following three approaches. These can be described as follows:

1. Development of protection devices and use of conventional (available) components and materials.

2. Development of component parts to meet the very severe environmental conditions by extrapolating the present state of the art.

3. Development of entirely new concepts of constructing electronic materials, search for fundamentally new devices, and a completely new approach to design concepts.

THE first approach consists of judicious selection of materials and components in the design of the equipment and by shielding, cooling, insulating, pressurizing, shock mounting, potting, or by other means protecting the electronic equipment from the severe conditions. In this respect some ingenious ways of cooling by using the latent heats of melting or evaporation are being developed.

The use of various cold-plate methods has been proposed and tried in which the equipment to be cooled is mounted directly on a metal plate, and the plate is kept cool by air or liquid flowing through it. Special cooling packages using water, freon, glycol, or ammonia are being developed for short, high-speed flights.

A technique that is becoming popular is open-cycle evaporative cooling using water as an expendable liquid. The electronic equipment to be cooled is surrounded by a double-walled container filled with water. The heat generated by the equipment causes the water to boil off and restricts the temperature rise inside the container to the boiling temperature of the water. The water vapor is vented off.

This method normally would require complex baffles, spray nozzles, and intricate plumbing to prevent spillage in inverted flight or as a result of vibration. To prevent this, wick materials have been developed which absorb and retain the coolant liquids up to ninety per cent of the wick's volume and permit the liquids to be handled as solids.

The use of such wick materials allows one hundred per cent use of the latent heat of evaporation of the coolants. As the coolant evaporates, it keeps heat-transfer surfaces wet and permits submerged boiling. One such wick material is known commercially as "liquid lock."

This technique can be applied readily to equipment which is not required to operate for extended periods of time. Its great advantage is that it permits the use of conventional-type component parts, such as those that can withstand ambient temperatures up to 125 degrees centigrade. The temperatures outside the shield may rise as high as 300 degrees centigrade while the temperature inside, at sea level, is limited to a wall temperature of about 100 degrees with a gradient of about 15 degrees from the center of the equipment to the inner wall of the container.

It should be apparent that this technique is only a stopgap measure. The equipment is bulky, good only for as long as the coolant lasts, and requires a considerable amount of attention on the ground and in the air. The advantage that it has is that it is available and, with some refinement, ready for use.

The second approach consists of using known concepts and design techniques and developing, by the brute-force method, component parts which will withstand severe environmental conditions. This whole approach is based essentially on the replacement of materials readily affected by heat with high-temperature materials such as ceramics.

ONE of the larger programs is the development of ceramic tubes; another is the development of ceramic insulation for wire. Once sufficient components are available, circuitry can be developed by extrapolating well-known design concepts.

It is obvious that equipment designed from these components will in some ways be superior to that considered in the first approach; however, a sacrifice will probably have to be made in accuracy, range, and over-all operational effectiveness of the equipment as it is not believed possible to obtain at 500 degrees centigrade, even if the other environmental conditions are not considered, the same operational features as at room temperatures.

It is the Air Force's feeling that most of the advantages that available electronic materials and component designs offer have been largely exhausted, that the current engineering designs are predicated essentially upon readily available and understood techniques rather than upon limitations of materials or underlying basic physical laws. The improvements that are being realized today are being gained by applying refinements to the existing technology rather than breaking new ground.

FOR this reason an entirely different attack on the whole problem has been proposed. It is based on a program directed to the search for new materials, new techniques, and new design concepts. It requires that materials technology be advanced; that new properties of materials be sought and means of measuring them accurately be developed; that better understanding between material purity and its properties be obtained and that such correlations be exploited; and that the effect of controlled impurities be better established.

We are far from approaching the efficient and analogous processes occurring in nature such as protein synthesis, cell duplication, or energy conversion, and therefore much progress should be made in this direction. The little-known potentialities of currently available materials can certainly be developed by means of new methods of analysis and discovery of new techniques.

In other words, before the performance goals that the Air Force has set can be attained and the required components designed, considerably more information must be obtained on the electrical and physical properties of the available materials. This must be followed by the development of new and superior materials.

Carrier Weapons Handling

The Navy is meeting the challenge of conducting attack and defensive missions with increased speed and reduced warning time by integrating the tactical and logistic factors involving weapons, aircraft, and ships

Leo Steinhardt

TO perform its prime role as a base for several types of aircraft, each of which utilizes a variety of weapons for different missions, the aircraft carrier must have great flexibility in matériel handling. Provision must be made for the expeditious handling of many different aircraft-weapon mixes under any and all operating conditions.

While preparation for the initial strike presents problems, the ability of the ship's handling system to make available sufficient quantities of weapons to rearm the aircraft expeditiously for succeeding strikes also must be provided. Special attention is therefore being directed toward the rearming cycle subsequent to the depletion of initial quantities of ready-service weapons.

THE design of an aircraft carrier is a mammoth task, far more complex than most industrial undertakings. Since the weapons-handling function cannot be divorced from other functions with which it must compete and coexist, the over-all design of the vessel is the composite of an endless series of compromises between function and available space.

Various functions must be assigned to given spaces, the allocation being dictated by the more important functions within the ship. Each function must then be suboptimized or improved within the general framework of the basic compromise. Typically, aircraft armament, because of safety considerations and the need for compactness and maximization of payload, is assigned to the deep stowage spaces. Exceptions are small quantities of ready-service armament closer to the flight deck.

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Another complication is that weapons handling, in terms of elapsed time, represents but a small fraction of the total ship's activity. Although weapons handling may be of prime importance in fulfilling the ship's mission, and occasionally may be necessary for the ship's survival, functions such as providing for mess facilities and sleeping areas for the crew take high priority in the allocation of space.

Given the location of weapons in stowage, the theoretical problem then is to plan fast, direct transportation routes and handling equipment for bringing the ammunition out of stowage, through the assembly and check-out operations to the places where it will be attached to aircraft.

This is a warehousing problem, but, unlike conventional warehousing, it is one that is highly restrained by several characteristics, including naval architectural considerations and safety precautions.

For example, the locations of elevator shafts are less than ideal in many instances because of the need for preserving the ship's basic structural strength at points of stress and for the maintenance of watertight and fireproof integrity under varied operating conditions.

BY the same token, the ship's motion and other environmental conditions affect the design of weapons-handling equipment as do the logistical criteria that pertain to the ship's prolonged self-sufficiency. These considerations alone make it largely academic to attempt a comparison with an idealized industrial production process and its associated material-handling system. The differences are so vast that the governing philosophy here is to accept these unique restraints and attempt to improve the process within the ground rules.

The relative importance of ready-service weapons versus replenishment weapons is of prime concern in carrier design. In the ready-service concept, time is of the essence and some sacrifices in terms of space and condition of weapons must be made to meet the specifications for the initial arming load.

Since it is impractical to consider having all weapons in the ready-service condition, the problem becomes one of

considering weapons handling in terms of quantities required for an economical load, such as a full elevator load. Thus, weapons-flow rates are really rates for small discrete batches rather than for continuous flow.

For a given weapon, over-all flow rate is generally governed by magazine breakout time of weapon component parts and time required to assemble complete weapons. To achieve optimum flow rates, there are four areas in which improvements can be made: (1) the weapons themselves, (2) the magazines, (3) the handling equipment, and (4) the communication and control procedures.

Almost without exception, improvements to speed arming yield corresponding acceleration in strikedown flow rates. Strikedown is the portion of the replenishment operation consisting of receipt of weapons from the ammunition ship or barge and stowage of the weapons or component parts of weapons in their assigned spaces. Strikedown of components also can be executed at dockside.

THE ship designer is confronted with the dual responsibility of providing equipment for arming and strikedown. These functions are closely interrelated, and in many cases they require identical equipment.

Although strikedown is not a combat function, it is an important one, since a prime requisite for effective at-sea naval operations is logistic support. This is particularly true in the replenishment and strikedown of ordnance matériel.

In addition to the obvious physical handling problems presented by transfer of ordnance matériel from one vessel to another under all kinds of environmental conditions, a more important consideration is the time lost by combat vessels during replenishment operations. Added to this are the involved risks of equipment and matériel damage, personnel loss, and the increased vulnerability of both vessels to attack during this operation.

It becomes increasingly necessary, therefore, to improve the efficiency of the over-all strikedown operation to derive two main advantages: (1) Reduction of time required to effect transfer from supply vessel to combat vessel, and (2) reduction of time necessary for the combat vessel to handle and stow the transferred matériel. At the same time, lesser advantages accrue through greater predictability of output and reduced manpower requirements.

If meeting the specified rate is judged to be of highest importance, this can be done through mechanization at additional cost, lowered reliability, and reduction in space factor. This price can be minimized by wisdom in selecting design concepts and adherence to best possible execution of mechanical and electrical design.

When determining whether a change in a handling system is worth while, the designer has to know what the theoretical upper limits of the system's capability are, assuming all changes were incorporated to the fullest degree. Unfortunately, these upper limits cannot always be precisely stated.

Data on the capabilities of the British ARK ROYAL system, for example, might be useful as a yardstick to indicate the capabilities of a fully mechanized system. However, this fully mechanized system might not be ideal in terms of flexibility for accommodating growth and changes in weapon configuration. Also, reliability problems that go along with increased mechanization and complexity might preclude the adoption of such a system.

Sometimes improvements can be achieved merely through physical rearrangement, better programming, and better training of personnel.

One important principle must always be borne in mind—large gains can be effected in all activity from the second deck downward to the deep stowage areas by means of increased mechanization with correspondingly less flexibility. However, in second activity and subsequent movements to the hangar or flight deck, flexibility is a premium consideration because of unknown factors such as location of aircraft and interference with other ship's functions.

Handling equipment must be adapted to the unique conditions imposed by shipboard environment and so may preclude the adoption of popular industrial-type automatic handling systems.

In April 1957, the Bureau of Ships awarded an engineering survey contract to American Machine & Foundry Company. Under the terms of the contract, A.M.F. engineers were to study present shipboard systems and determine the adequacy of magazines, elevators, assembly areas, and handling equipment for strikedown, arming of aircraft, and check-out of aircraft ordnance.

THE U.S.S. SARATOGA (CVA-60) and the U.S.S. RANGER (CVA-61), then under construction, were selected as subjects for study. Preliminary surveys of magazines, assembly areas, check-out spaces, handling routes, and aircraft-arming facilities were made at dockside. Recommendations from forces afloat and from naval establishments regarding redesign or improvements to the system were collected.

Observations of actual arming operations at sea aboard the CVA-60 were made using motion pictures and industrial time-and-motion-study techniques. These observations were monitored by personnel of the Navy Bureau of Aeronautics and the Bureau of Ordnance. Close cooperation of both Bureaus with the Bureau of Ships facilitated the correlation and analysis of the data.

In addition to the strikedown sequence, aircraft-ordnance-handling operations were studied. This covered all movements from the stowed position in the magazine through the assembly operations to the hangar deck and flight deck. In the case of guided missiles, studies were made of the transfer operations from the stowed position to the missile check-out station and the return of checked out missiles to storage.

Elemental times were recorded on precision stop watches for all operations in the handling, check-out, and assembly of each weapon in the aircraft-ordnance load. These data were later used to establish the maximum rate at which the system operates effectively and the points within the system where improvements could be made.

The weapon-handling system proposed for the nuclear-powered aircraft carrier CVA(N)-65 was analyzed in

detail and its capabilities predicted from data collected on present shipboard systems. The arming capability of this carrier also was determined in terms of flow rates from ready-service magazines and replenishment-component magazines.

From this information, a projection of the capabilities for the CVA(N) in relation to the design specification established for it was achieved. Valuable by-products of these analyses were an accurate comparison of the CVA(N) and CVA-60 system performance and a determination of manpower requirements necessary to satisfy established flow rates.

The collection of time-study data for this naval situation presented problems which called for modification of conventional industrial time-study techniques. The tests were conducted in two parts. In Part I, a composite activity chart, a variation of the Gantt chart widely utilized in industry, was constructed for each ordnance item. This chart related the elapsed time for a series of operations to a common time scale and gave a picture of time relationships between the various operations in the system.

The U.S.S. SARATOGA, one of two carriers involved in the weapons-handling study.

FOR each item, a flow diagram was drawn showing the physical path of matériel movement. Within this analytical framework, stop-watch data on each operation broken down into basic elements were recorded. Composite time values for each operation were then used to plot the composite-activity chart. During this study, wristwatch times for all members of the observer team were synchronized.

The elemental time-study data were later used to establish synthetic time values for alternate flow paths and to project time values for newer weapons as yet untimed. The data were also applied in extrapolating manpower requirements for several combinations of aircraft loads. These observations of individual weapons thus yielded "building-block" information applicable to the solution of many related problems.

In Part II of the tests, combinations of weapons-handling sequences were observed and timed. Tests were conducted simulating arming requirements for typical aircraft missions. Observers were stationed at key points to spot interferences within the weapon sequence and competition for common facilities such as upper-stage elevators. Thus, the interactions of several areas of activity were measured and recorded.

The Part II tests also enabled subsequent calculation of the theoretical maximum arming rate for each item and the location of points in the flow sequence where time could be saved.

While the building-block observations of Part I were not repeated during Part II, the composite rate count of the weapon mix was established from the data acquired by the observers. Attention was directed toward the following: (1) input of components, (2) assembly operations, (3) transport, and (4) arming. The magazines were not observed during Part II because they are amply serviced by elevators, and interference effects are negligible.

To complete the contract for the Bureau of Ships, A.M.F. had to analyze all the survey data and make recommendations for areas of future development. One criterion was paramount—reduction of time to do the work. It is a foregone conclusion that adoption of a developmental program entails a price in terms of dollar cost, increased complexity, reduction in space factor, etc.

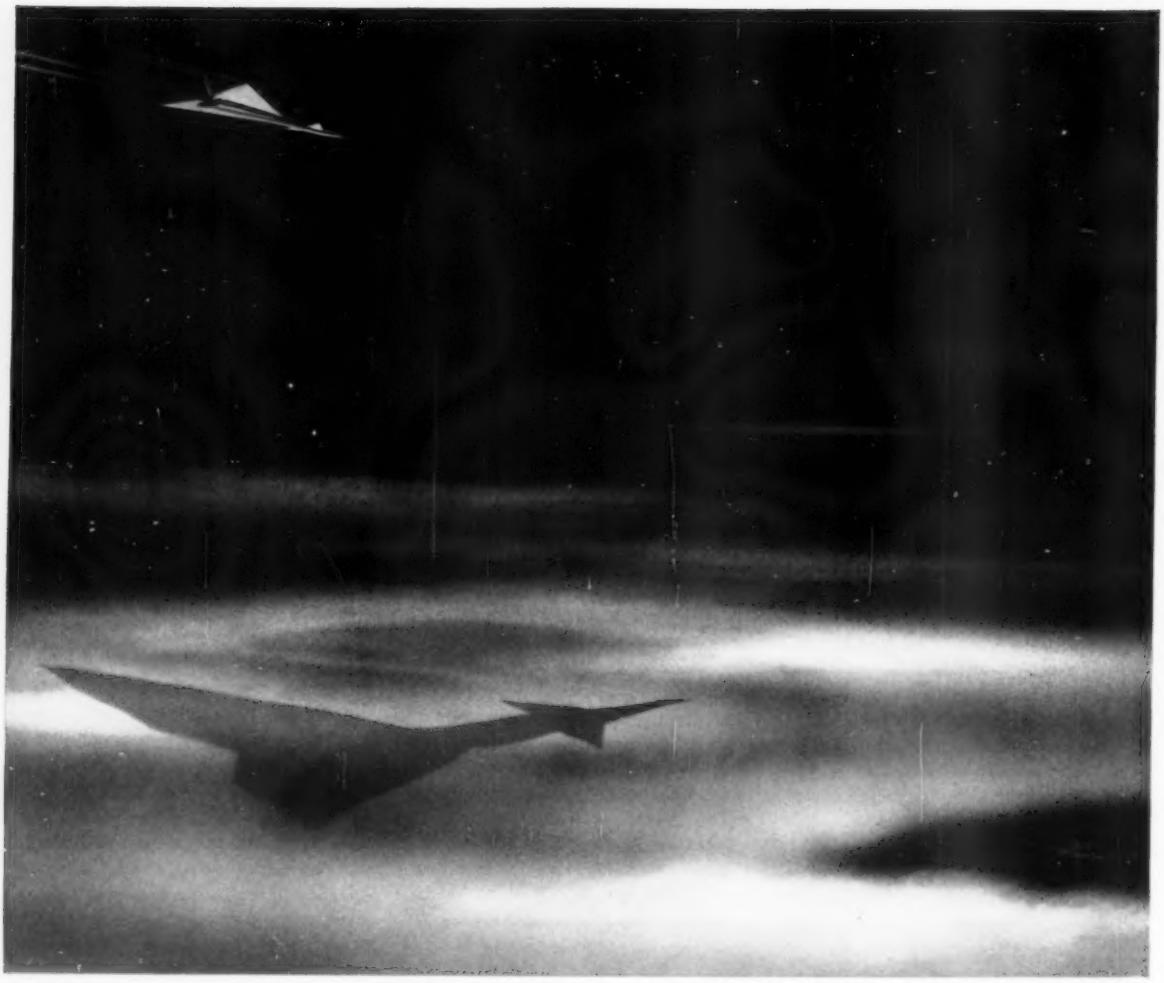
But the final implementation must be based on careful judgment in which the price is weighed against the more important advantages to be gained in better and faster execution of missions.

Once the feasibility of the many ideas for improvement was established, priority in the selection of developmental areas must be based on an evaluation of those changes which will yield major areas as follows: (1) weapons and packaging, (2) handling equipment, (3) ship's facilities, (4) layout and arrangements, (5) procedures and doctrine, and (6) communication and control.

A cursory examination of the above list reveals the wide variety of factors contributing to over-all system effectiveness.

Logistic criteria, such as provision for handling, packaging, and unpackaging, must be borne in mind as well as weapon weight. Human-factor criteria determine the weight range which permits handling by one or two persons; beyond this range mechanical equipment must be considered to achieve efficient operation.

IN the final analysis, the job of the aircraft-carrier designer is a difficult one. Through exhaustive study, he must determine those points in the ship's weapons system where development activity will increase effectiveness in supporting the armament needs of her aircraft. In this way, promising possibilities are created for greater improvement in the powerful combat capability of these prime naval vessels.



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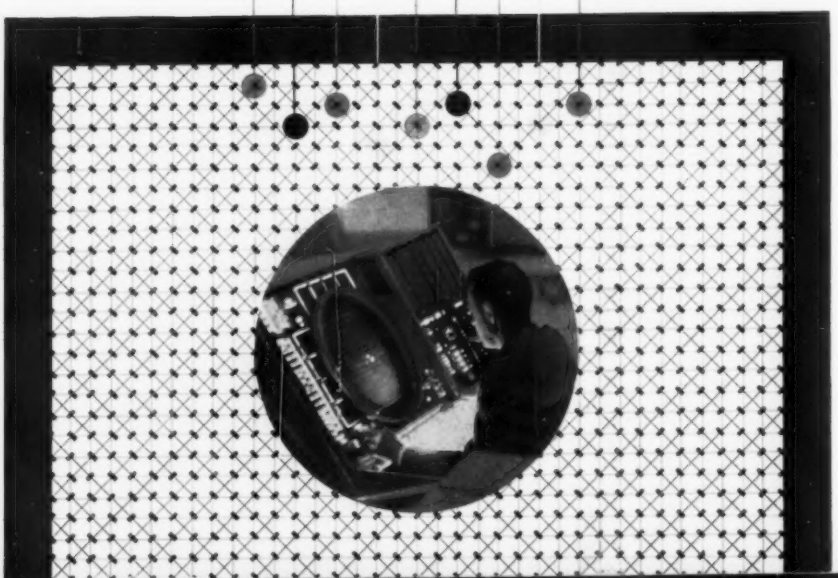
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